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ABSTRACT

A study was designed to investigate and evaluate the development of a computer-assisted instruction (CAI) phonics program. The program was administered to 36 students enrolled in an undergraduate reading methods course. Subjects were pretested, and based on pretest performance, they were branched to CAI which included illustrative lessons, student self-evaluation, and computer-evaluation of multi-lined constructed responses. Results of analyses of pretest and posttest data showed that the course was valid for instruction at the designated level--a comparison of the pretest and posttest performance revealed significant gains for each student. Recommendations for future research and course optimization include requiring the course for preservice reading teachers and using these groups for future revisions, incorporating a mastery model, and including some consequential evaluation of the revised course. EM 011 037 through EM 011 043, EM 011 046, EM 011 047, and EM 011 049 through EM 011 058 are related documents. (SH)

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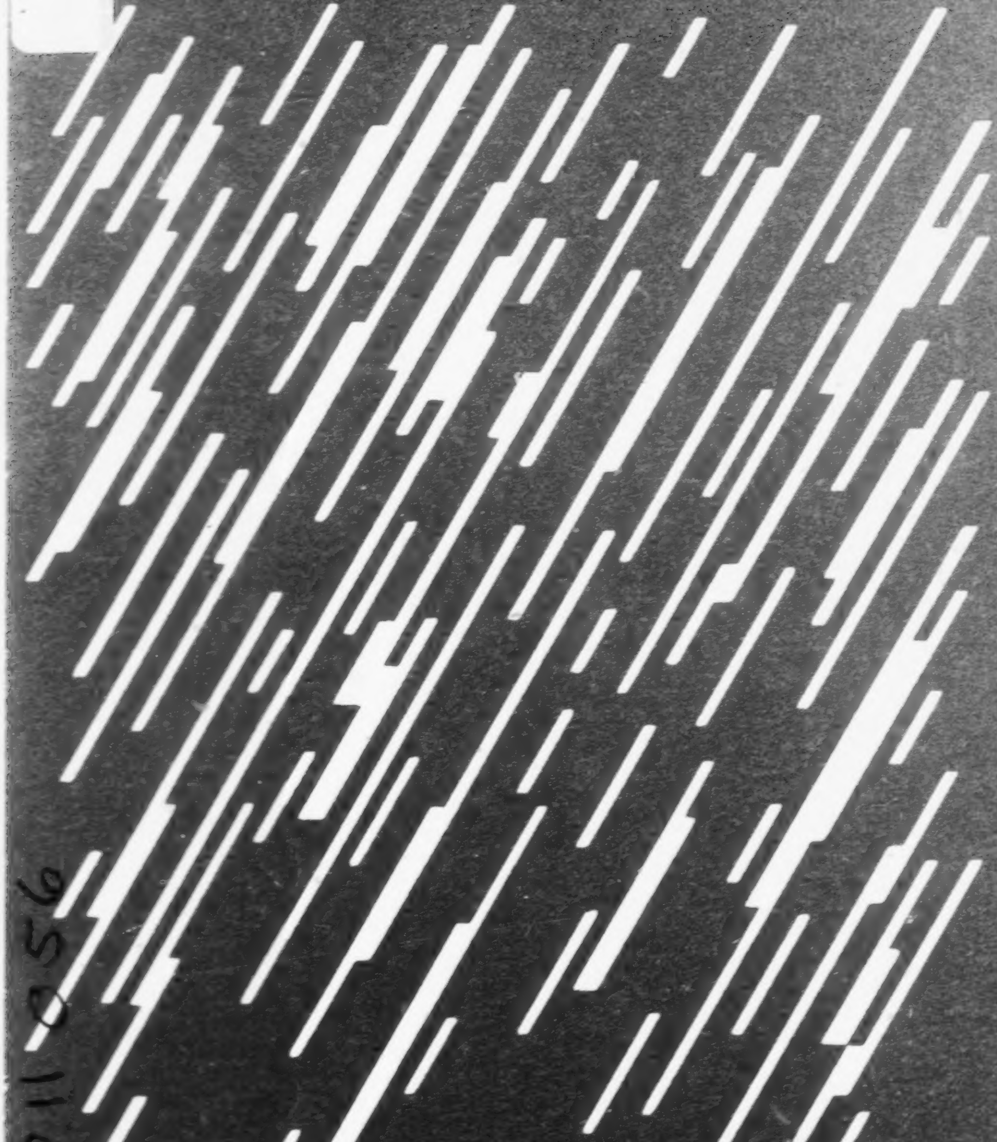
**THE COMPUTER ASSISTED
INSTRUCTION LABORATORY
THE PENNSYLVANIA STATE
UNIVERSITY**

Report No. R-52

Computer Assisted Phonic Analysis: A Validation Study

Ruby L. Thompson



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Note to accompany the Penn State Documents.

In order to have the entire collection of reports generated by the Computer Assisted Instruction Lab. at Penn State University included in the ERIC archives, the ERIC Clearinghouse on Educational Media and Technology was asked by Penn State to input the material. We are therefore including some documents which may be several years old. Also, so that our bibliographic information will conform with Penn State's, we have occasionally changed the title somewhat, or added information that may not be on the title page. Two of the documents in the CARE (Computer Assisted Remedial Education) collection were transferred to ERIC/EC to abstract. They are Report Number R-36 and Report Number R-50.

Jaclyn Carroll/ERIC/EM

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Computer Assisted Phonic Analysis: A Validation Study

by

Ruby L. Thompson

An Abstract of a Thesis
in
Secondary Education

Submitted in Partial Fulfillment
of the Requirements
for the Degree of

Doctor of Philosophy

March 1973

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ABSTRACT

Computer Assisted Phonic Analysis: A Validation Study

This study was designed to determine whether or not a computer-assisted instruction phonics program could be developed and validated so that 80 percent of the subjects would achieve 80 percent of the terminal criterion objectives. Several related purposes of the study were to answer these questions:

1. What is the general status of the preservice teachers' knowledge in phonics prior to the computer-assisted phonics program?
2. How effective were the cueing and practice materials of the program as determined by the difficulty level (80 percent) of the mastery items?
3. Which criterion test items met the 80 percent criterion level and which warranted revision?
4. What is the feasibility of the instructional strategies and tactics employed in the testing and instructional programs?
5. How efficient were the authoring and technical operations during program development and operation?

The program was administered via the IBM 1500 Instructional System to the validation group during the fall of 1972. Each of the 36 students in the validation group was an undergraduate and enrolled in the undergraduate reading methods course. The students were administered the pretest, branched to instruction based on pretest performance and administered a posttest off-line.

Posttest performance indicated that the course was valid for instruction at the designated level for the subjects with whom it was used. The analysis of the incourse materials revealed that more than 75 percent of the mastery items recorded difficulty levels at or above 80

percent. A comparison of the pre and posttest performance revealed empirically significant gains for each student. These gains indicated that the CAI program was effective in changing the behaviors of the students.

The strategies of branching based on pretest performance, the use of illustrative lessons, student self-evaluation, computer-evaluation of multi-lined constructed responses proved to be viable strategies.

The operations analysis showed maximum use of the computer, preplanning, as assets of the course development phase. Some limitations of course operations were pointed out: last minute changes, rush for data from student records, lack of coordination of staff personnel during the initial phases of the program.

These recommendations were made for further research and course optimization:

1. The course should be a required unit of instruction for preservice reading teachers and that these future groups be used for updating and optimizing the course.
2. A "mastery model" should be incorporated and that this mastery model be tested with a 90/90 criterion level.
3. Some consequential evaluation should follow the revised course so that the effects of the program on changing teachers' classroom behaviors may be determined.
4. Researchers and course developers should use a minimum of three testing groups with a minimum of 15 students typical of the validation population before running the validation study.

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CHAPTER I

INTRODUCTION

Origin of and Need for the Study

More than a decade ago, a conference of reading experts (Learning to Read, 1962) reported a consensus on the value of phonics:

> We consider phonics one of the essential skills that help children identify printed words that they have not seen before and then understand the meaning that these words represent. Without phonics most children cannot become self-reliant, discriminating, efficient readers. [p. 3]

This statement set the stage for further individual testimony regarding the importance of phonic analysis. Smith (1963) alleged that word recognition is the most fundamental of the reading skills and that without the ability to recognize words, the reading process cannot proceed. McEathron (1963) paralled Smith's (1963) allegation by attesting that many children will never master reading skills unless they are well taught the simple phonetic principles. Heilman (1968) pointed out that children must learn to associate speech sounds with the printed letter representations. In fact, he believes that if a pupil does not develop a technique for "sounding out" unfamiliar words, his chances of becoming an independent reader are slight. So important is this skill to children that it must be taught systematically and well.

Moreover, skill in teaching phonic analysis has been designated one of the most essential skills for reading teachers. (Betts, 1955; Heilman, 1968; Curry and Rigby, 1969; Spache and Bagget, 1965).

Norton (1959) pointed out that successful teaching of reading at the intermediate level was dependent on teachers acquiring a sound knowledge of the basic skills involved in word recognition.

While the need for good phonics instruction for children has been firmly established, there are serious doubts regarding the adequacy of phonics instruction in classrooms today. Research (Bond and Tinker, 1967) into reading disability reveals that lack of or ineffective word analysis skills is one of the major disabilities among disabled readers in the elementary schools. This finding extends into the high schools and colleges where, as Ford (1971) observed, more than half of the students entering the small colleges are disabled readers whose major impediments are the inability to recognize words quickly and accurately, divide words into syllables and pronounce words. She concluded, from her experiences, that these students will not gain much from training in vocabulary development, rate and comprehension unless they master word analysis skills.

While the causes of reading disability tend to be complex, one factor contributing to many reading disabilities is ineffective teaching (Bond and Tinker, 1967). But to what may inadequate teaching be attributed? It is realistic to assume that pre and inservice teachers want to do a good job. One reason that they do not do so is that they have not been taught how and in some cases what to teach. This hypothesis is based on the theory (Popham, 1965) that the relationship between teacher effectiveness and teacher knowledge of content is positive and high. Granted that this theory is sound, one training source to be reckoned with is the teacher training institution.

An investigation directed by Austin (Austin; Morrison, C.; Kenny; Morrison, M.; Gutmann and Nystrom, 1961) revealed that many prospective teachers do not have the necessary knowledge base in phonics. The investigators reported that college supervisors and cooperating teachers agreed that the greatest content deficit of student teachers in reading was a lack of understanding of phonetic principles. This group of experts recommended that college instructors take greater responsibility in making certain that their students have mastered the principles of letter-sound relationships and structural analysis.

Farinella's (1960) appraisal of teacher knowledge of phonetic and structural analysis led him to conclude that while teachers readily admit the importance of phonic analysis instruction in their jobs as reading teachers, they lack the necessary knowledge to teach these skills. Studies by Aaron (1960) and Spache (1965) disclosed that the teacher subjects in their respective investigations had limited knowledge of phonics and syllabication and confirmed the need for upgrading preservice instruction in phonics and phonics principles for primary and intermediate grade teachers.

It is highly probable that the extensiveness of the phonics content does not render it likely to receive the full and intensive coverage that such an important word analysis skill merits. Hence, preservice teachers are given an overview of phonics in their methods courses that is hardly sufficient to give them the necessary knowledges and skills for teaching phonic analysis effectively.

Hull (1969) reasoned that the training of teachers in methods courses--specifically in the area of phonics--is probably ineffective because the teaching of phonics content and the strategies and principles involved in teaching phonic analysis are enormous and time consuming tasks. Spache and Baggetts' (1965) and Aaron's (1960) findings do not suggest that teachers will learn to teach letter-sound relationships effectively simply by teaching. For while experienced teacher groups appeared to know more phonics than did inexperienced teachers, neither group's collective knowledge was impressive. Winkley, (1971) after years of work with graduate students and inservice training programs for reading teachers, avered that the average teacher of reading does not know as much phonics as the average third-grade pupil.

Present elementary school classroom instruction in phonic analysis demands that preservice training take on a greater responsibility in helping teachers master the content of phonics instruction before going into the classroom. To date, preservice methods courses have not met this responsibility fully. The state of methods courses is viewed by reading specialists (Norton, 1959; Austin, 1961; Spache, G. and Spache, E., 1971) as warranting review and revision mainly because classrooms are manned by men and women who are not fully prepared to teach reading.

The question of how to best provide the content and procedural guides for phonics instruction that are needed by teachers has not been answered in the literature. Having teachers learn on their own appears to be inadequate; "learning while teaching" seems to be too risky for it cannot be assumed that pupils are receiving a good and systematic base in phonics while their teachers learn; methods courses apparently lack the time to go into the content of phonics thoroughly.

While methods courses have been appraised and methods course teachers apprised of the limitations of the courses, little has been initiated to effect positive change. Teachers have been constantly impressed with their responsibility for teaching phonics; methods courses have been handed directives for content. Unfortunately, very little concrete instructional improvement has been generated by the criticism. It has been recommended that teacher-education institutions conduct research to investigate and determine the feasibility of various types of programs which are purported to be promising in instructional quality. Few programs have been investigated. Possibilities for educating teachers in phonics must be explored if the problem of poor phonics instruction in the classroom is to be alleviated.

Since the content of phonics and procedures and principles for teaching phonic analysis to children are so inclusive, it is very unlikely that preservice teachers could master the content even if a larger segment of time were appropriated in methods courses. There would be many students receiving both repetitious information and practice; too many students would not get enough practice to master the content. Students' prior knowledge, learning rates and working rates are all variables to be considered and accommodated if learning is to be optimized. If every student were provided only that information necessary for him to achieve certain prescribed objectives and if he were presented that information at a rate and in portions suitable for him, it is axiomatic that most learners would achieve mastery of the material to be learned. Such an approach to learning is called the Individualized Approach.

Research (Klaus, 1969) contrasting the conventional methods of teaching and approaches which focus on learner performance suggests that efforts to individualize instruction so that each learner can receive the practice he needs for complete mastery are far more effective than solutions which stress the communication and presentation characteristic of educational methods. Klaus (1969) has pointed out however, that the application of individualized instruction in education has been limited because there has been the problem of devising techniques to provide the necessary control over learning in the absence of human supervision for extended periods of time.

It may be reasoned that individualized instruction is the best approach for teaching phonics content to preservice teachers. The search for a technique through which individualized instruction might reach fruition was undertaken. At the moment, educational technology--in the form of computer-assisted instruction--appears to hold considerable promise for optimizing, by individualizing, instruction in phonics for preservice teachers.

Research with computer-assisted instruction indicates that these computer systems can accommodate a variety of subject matter content and different types of learners. The ultimate success of a CAI course depends on the quality of the course materials developed; however, the opportunities offered for individualizing, sequencing and controlling instruction and adapting to various learning rates enhance the effectiveness of the presentation of the materials to be learned.

The principles[1] undergirding computer-assisted instruction (CAI) lend themselves well to the construction of an ideal learning environment:

1. The learner is an active participant.
2. Repetition of tasks is achieved through reorientation of stimuli rather than by repetition of the same stimuli.
3. There is a deliberate plan to present a range of conditions to which learning must be generalized.
4. Novelty accompanies learning.
5. Knowledge is gradually presented in levels of difficulty.
6. Feedback dimensions are both cognitive and evaluative.
7. Learners are involved in goal setting, pacing and evaluation.
8. Different kinds of thinking are stimulated.

The application of these principles in developing a CAI course in phonics should result in a blending of the teaching process and the content to best meet the needs of the learner. This is something[2] that many teacher-training courses do not now effectively accomplish.

More specifically, CAI has been selected as the media through which an effective teacher training course in phonics may be realized because the system[3] offers the rich interface components--audio units, image reels--that are important to phonics learning. A description of the IBM 1500 Instructional System and a configuration of the CAI system are found in Appendix A. In addition, the learning of the phonics material by the prospective teacher may be virtually guaranteed with a tested and validated course; this statement may not be justified if it is made about traditional classroom exposure, independent student work or the use of the programmed text.

---

[1] L. Stolurow, Instructor, CAI Seminar sponsored by Control Data Corporation, Silver Spring, Maryland, May 25, 1971.

[2] Ibid.

[3] The system referred to is the IBM 1500. It must be mentioned that not all terminals or systems offer the interface components named.

In order to determine the viability of computer-assisted phonics instruction for teachers, a CAI program was developed for testing and validation.

Overview of the Objectives

The primary objectives of this exploratory research were to develop, test, revise, retest and validate a CAI program in phonics for preservice teachers. To implement these objectives, the following were produced:

1. Scope and sequence of instruction
2. Terminal criterion behavioral objectives
3. Criterion test items
4. Instructional materials suitable for the CAI system components--cathode ray tube (CRT), audio unit, image projector
5. Flowcharts of instructional processes and decisions
6. Course validation plan and validation data
7. Course documentation

Specific Statement of the Problem

The specific problem of this research was to answer the question: Is the CAI Phonics Program effective to the extent that 80 percent of the learners attain 80 percent of the terminal criterion objectives enumerated below?

1. The learner will name four prerequisites for phonics instruction.
2. The learner will identify the relationship of each prerequisite to phonic analysis.
3. The learner will identify the distinguishing quality of a consonant blend.
4. The learner will name each of the two-letter (r, l, and s) consonant blends.
5. The learner will describe the distinguishing quality of a consonant digraph.
6. The learner will name the seven consonant digraphs and the single letters which represent digraph sounds.
7. The learner will write one key word for each short vowel sound.
8. The learner will correctly syllabicate two words and give the syllabication rule for each word.
9. The learner will state the compound generalization for short vowel sounds in one-syllable words.
10. The learner will identify each instance in which y stands for a vowel sound and name the vowel sound represented in each instance.

11. The learner will name the instance in which w stands for a vowel sound and describe the vowel sound which results.

12. The learner will write a one-syllable key word for the long sound of each vowel.

13. The learner will state in writing the "final e" generalization.

14. The learner will state in writing the "single, final" vowel generalization for long vowel sounds.

15. The learner will write the "adjacent-vowel generalization."

16. The learner will name the six "regular vowel digraphs" that complete the modified "adjacent-vowel generalization" which applies to these regular digraphs.

17. The learner will describe the distinguishing quality of a vowel diphthong.

18. The learner will describe the distinguishing quality of a vowel digraph.

19. The learner will name the four common diphthongs and write a key word illustrating the diphthong sound of each combination.

20. The learner will state the rules covering at least six of these letters--k, g, gn, w, h, l, t and b when these letters are not sounded in words.

21. The learner will state the generalization for hard and soft sounds of c and g.

22. The learner will write one word in which s stands for its most common sound.

23. The learner will name the vowel letter that accompanies q in order for q to be sounded in a word.

24. The learner will describe the "schwa" sound and name the syllable in which the "schwa" sound occurs.

25. The learner will tell how and when r affects vowel sounds.

26. The learner will correctly label oo sounds in words.

27. The learner will write that al, all, aw, and au record the same sound.

28. The learner will describe the change in the sound represented by the letter i when it is followed by nd, gh, and ld.

29. The learner will write a rule that accommodates the influence of ld on the sound represented by o.

30. The learner will sequence the general procedural steps for introducing letter-sound relationships. This will be done from memory.

31. The learner will arrange the phonic elements in an acceptable hierarchy for presentation to children.

32. The learner will state from memory at least three principles to be observed in teaching letter-sound relationships to children.

Related Purposes

Though the specific objective was to determine whether the course met the preestablished validation level, other ways of assessing course efficiency were employed. One assessment dealt with the effectiveness of the instructional materials within the program. This analysis was undertaken to measure the difficulty levels of the incourse mastery items. The 80 percent difficulty level was selected as a desirable level for measuring the efficiency of the instructional materials in that it was compatible with the course validation criterion level. A mastery item and the related practice and cueing materials were judged satisfactory if the mastery item recorded a difficulty (the percent of students attaining mastery of the item) of 80 percent or higher. This analysis would indicate whether the instructional materials were reliable.

The analysis of pretest data was used as another measure of course effectiveness. If it cannot be proven that the course itself supplied the learner with the knowledge, then the true validity of the course is questionable. Pre and postcourse data were compared to see if the course changed the learners' behaviors or whether the behaviors were present without the course.

Another way of analyzing the course was to determine the effectiveness of the instructional strategies and tactics employed. This analysis was undertaken with no specific guidelines; however, the performance of the students was used to determine if the strategy was feasible.

The course was also analyzed according to the percent of the learners meeting each terminal criterion objective. Even if a course is deemed valid, if the majority of the learners do not achieve each objective, then the objective warrants investigation. The criterion of 80 was applied to the terminal test items.

In order to fully evaluate the end product, the processes used in developing and operating the product were investigated. The opinions and views of the personnel who provided the technical support during course development and course operation were analyzed.

The supplementary analyses can be viewed as related purposes of the study. These related purposes were to determine the following:

1. What is the general status of the preservice teachers' knowledge in phonics prior to the computer-assisted Phonics Program?
2. Which incourse practice and cueing materials and mastery items do not meet the 80 percent difficulty level?
3. Which criterion test items are not being met by the majority (80 percent) of the students?
4. How feasible were the instructional strategies and tactics employed in the testing and instruction?
5. How efficient were the authoring and technical operations for the program?

Definition of Terms

The following concepts are basic to reading this study and the related literature:

Analogous practice. An activity similar but not identical to the final criterion activity.

Branch. A generic term for the point of choice at which students are sent to alternative frames within a program depending on their responses to the particular branching point. Responses may be to diagnostic test items, in-program frames with multiple-choice or constructed-response items, and so forth. The branch may take the student to a single frame (a remedial loop) or a linear sequence dealing with his particular needs.

Branching intrinsic. A programming technique characterized by consistent use of branching. If after reading the information section of each item, the student selects or makes the correct response to the question based on the materials, he is sent to an item presenting new information. If he selects an incorrect alternative, he is sent to an item which provides information as to why his choice was incorrect. To the extent that the programmer has correctly predicted the possible response that the student population will make, the program taken by each student is under the control of his own responses, and will differ for students of differing abilities.

Cue. A verbal statement providing the minimum information required by the learner to perform the desired behavior.

Computer-assisted instruction. The operational definition of computer-assisted instruction is derived from the functions of the computer in this research project. Here, CAI is defined as computer-administered and computer-controlled instruction in which the total components of the instructional program are presented by the computer system. The interactions for learning are completely between student and computer. The system presents the initial stimuli and urges learner responses. These responses are evaluated by the system and followed by feedback, reinforcement and evaluation. This particular use of computer-assisted instruction is labeled "tutorial."

Criterion level. The criterion level is that preestablished level used to determine if the objectives of a project have been met. The criterion level indicates what percent of students must succeed in passing a certain percent of test items in order to validate the effectiveness of the program. An example of a criterion level is this: ninety (90) percent of the students must pass ninety (90) percent of the criterion test items.

Criterion-referenced test. A criterion-referenced test is a test that is deliberately constructed to measure specified performance behaviors. The measurements are interpreted in terms of whether an individual can demonstrate the specified behavior. There is no referencing these measurements to other individuals.

Documentation. Course documentation is the provision of factual and substantial support for statements made about a program. The program documentation includes at least the following information: number of persons tested, description of target population and intent of program, minimum acceptable standards for validation and the percentage of attainment of the criterion levels, the method used to validate the hierarchy, the results of that validation and the mean time for instruction.

Formative evaluation. Formative evaluation is systematic evaluation in the process of curriculum construction, teaching and learning for the purpose of improving any of the three processes. The focus is upon the alteration of a program during its development. Formative evaluation is the collection of appropriate evidence during the construction and trying out of a new curriculum in such a way that revisions of the curriculum can be based on this evidence.

Program. The total organization of all subject matter, strategies and techniques designed to achieve specified levels of student performance in a major occupational speciality on a major task or skill area.

Summative evaluation. That evaluation that takes place at the end of a period of instruction in order to grade or certify students on the unit, chapter, course. The main goal of summative evaluation is to judge the overall effectiveness of each aspect of a program.

Student records. The detailed records, maintained automatically by the computer, of a student's performance on each question. These records are stored on the log tape and are available to course authors for analyzing their programs.

Terminal behavior. The desired learner behavior or end product for any one unit of behavior on instruction.

Validation. Validation provides information on the extent to which a program has resulted in the desired changes in the behavior of the learner. Validation for this project will determine whether students learning phonics content and instructional procedures via this program will acquire the terminal objectives as established by the author. The student's posttest score--his terminal behavior--is compared to the criterion level established at the outset of the program. If the population meets criterion level the course is deemed valid. In short, validation is an experimental demonstration that the final version of a program does achieve its objectives as measured by its criterion instrument, up to a certain standard of performance for a given population.

Delimitations of the Study

1. This was a feasibility study which developed, tested, revised, retested and validated a computer-assisted program in phonics for preservice reading teachers.
2. The instructional program included selected phonics content.
3. The major focus of the evaluation was formative.
4. Provisions for individual differences in the construction of the learning environment included rates of learning and previous knowledge.
5. The subjects were preservice teachers enrolled in reading methods courses.
6. The findings, conclusions and recommendations of the study are generalizable only to the preservice teachers who were subjects in the study.

CHAPTER II

REVIEW OF RELATED LITERATURE

Purposes for Review

The research question to which the review was directed was: Can this CAI phonics program effectively teach 80 percent of the preservice reading teachers so that they can attain 80 percent of the terminal criterion objectives?

The literature was initially reviewed to obtain data which confirmed the need for teacher training in phonics and which supported the educational significance of the study. In addition, the literature was searched for information about the suggested instructional alternative--CAI--in order to secure data regarding appropriate techniques for implementing and researching computer-assisted instruction programs.

These major sources were consulted in the literature search:

1. The Reading Teacher, The International Reading Association, Inc., Newark, Delaware, 1950 - 1972.
2. The Journal of Reading, The International Reading Association, Inc., Newark, Delaware, 1957 - May 1972.
3. Reading Research Quarterly, The International Reading Association, Inc., Newark, Delaware, Fall, 1965 - Summer, 1972.
4. Educational Technology, Educational Technology Publications, Inc., Englewood Cliffs, New Jersey, 1968 - 1972.

5. Journal of Educational Research, Dembar Educational Research Services, Inc., Madison, Wisconsin, 1965 - 1972.

6. Automated Education Handbook, (edited by E. H. Goodman), Automated Education Center, Detroit, Michigan, 1965.

7. Programmed Instruction Guide, Northeastern University, Entelek Incorporated, Newburyport, Massachusetts, 1967.

8. Computer-Assisted Instruction: A Survey of the Literature, (edited by A. E. Hickey), Entelek Incorporated, Newburyport, Massachusetts, October 1968.

9. Computer-Assisted Instruction: A Book of Readings, (edited by R. C. Atkinson and H. A. Wilson) Academic Press, New York, 1969.

10. Index to Computer Assisted Instruction, (edited by H. A. Lekan), Harcourt, Brace and Jovanovich, Inc., New York, 1971.

11. O. D. Barnes and D. B. Schreiber, Computer-Assisted Instruction: A Selected Bibliography, Association for Educational Communications and Technology, Washington, D. C., March 1972.

In addition, technical reports on file from the major CAI Centers listed below were surveyed:

Florida State University, Tallahassee, Florida
Harvard University, Cambridge, Massachusetts
University of Illinois, Urbana, Illinois
The Pennsylvania State University, University Park, Pa.
Stanford University, Stanford, California
U. S. Naval Academy, Annapolis, Maryland

Literature Divisions

The review of the literature is reported in four sections. The first section presents an overview of phonics in the reading program and information about teacher knowledge of phonics. Section two focuses on modes of computer-assisted instruction and curriculum implementation procedures. Section three reports on selected computer-assisted instruction programs in high school, college, and teacher education areas. The final section looks at current views of criterion-referenced measures.

Time span of reviews. The literature dealing with phonics in the reading program and teacher knowledge of phonics extends from the earliest issues of major reading publications to the present--roughly 22 years. An inclusive overview was justifiable in that phonics and the history of the controversy about phonics are far-reaching.

The review of the literature related to computer-assisted instruction covers not quite a decade. This span, while seemingly limited, is the extent of the major time boundaries for CAI. Computers are no more than two decades old; the application of computers to education is even younger. Hence, the studies, theories and explorations regarding CAI were found in literature of the last decade.

While criterion-referenced tests have been mentioned in the literature as far back as 1950, the coverage here is limited to the sixties and early seventies because it was not until that time that criterion-referenced testing was viewed from the CAI perspective.

Phonic Analysis

The literature on phonic analysis was reviewed to support the claim that phonic analysis has emerged as an important learning tool for beginning readers.

Current status in reading instruction. The literature in educational and psychological research abounds with reading theories and studies. Within the more narrow arena of reading research lies a plethora of far-dating and controversial writings about phonics. Not only has phonics been the topic of professional literature, it has also had continuing heydays in popular lay media.

What specifically is phonics?[1] Phonics is the study of speech sounds and their printed representations. DeChant (1970) notes that "It [phonics] is the study of sound-letter relationships in reading and spelling [p. 288]." Phonic analysis is the process of arriving at the pronunciation of a word by "sounding" letters and letter combinations.

Phonics instruction, the teaching of letter-sound relationships, entered the classroom as early as 1912 and was then viewed as a "method" of teaching reading. Numerous experiments pitted phonics as a method against various other reading approaches. Findings ranged from no differences in achievement between groups to superior achievement of one group over the other.

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[1] The terms "phonics" and "phonetics" are sometimes used interchangeably; but they are not synonymous. Phonetics is the term used to designate the science of speech sounds (Cordts, 1965). Phonics (Cordts, 1965) is the application of phonetics to the art of reading. Phonics deals with the speech sounds and the letters that represent the sounds in reading. Throughout this review, both terms will refer to the definition given for phonics--the study of speech sounds and their printed representations.

Out of these early studies that covered more than four decades [1912-1955] came little that was not debatable. Because of the incongruity of research findings, the status of phonics instruction fluctuated from a place of total emphasis in the reading program to an almost excluded status. It was in this state of flux that phonics instruction found itself when the impact of Why Johnny Can't Read (Flesch, 1955) gave phonics an impetus that was to last for years to come. The author of the controversial best seller contended that Johnny could not read because phonics was not being taught in the schools. While it is obvious that public interest was revived partly because of the emotional overtones of the publication, the interest was accompanied by new insights and different perspectives of phonics instruction.

Chall (1967) labeled the decade 1955 - 1965 as the period of systematic-versus intrinsic-phonics. This period marked the metamorphosis of the phonics issue from the earlier controversy of "phonics or no phonics" to "what and how much phonics."

Educators through the years have verbalized the change in the issues. Hoggard (1955) pointed out that a mere cursory examination of the professional literature on the subject of phonics would reveal that reading specialists, without exception, advocated the use of phonics in the teaching of reading. He pointed out that the problem for the teacher was not whether phonics should be taught, but rather how it should be taught.

Years later, Ramsey (1963) contended that the issue over the role of phonics in reading instruction was not whether phonics should be taught, but rather how much and how early. Still later, Bagford (1971) reiterated the same ideas by posing these questions as the main foci of the present phonics controversy: 1) How should phonics be included? 2) What content should be included? and 3) When should phonics be emphasized?

Chall (1967) summed up the great debate in phonics in this question: "Do children learn better with a beginning method that stresses meaning or with one that stresses learning the code? [p. 75]." She answered the question forthrightly:

> Here I can say briefly that it would seem, at our present state of knowledge, that a code-emphasis--one that combines control of words or spelling regularity, some direct teaching of letter-sound correspondence, as well as the use of writing, tracing, or typing--produces better results with unselected groups of beginners than a meaning emphasis, the kind incorporated in most of the conventional basal-reading series used in schools in the late 1950's and early 1960's. [p. 178]

Sustenance was added to Chall's contention in research findings. Gurren and Hughes (1965) compared 22 intensive phonics-taught groups with 22 gradual phonics-taught groups. The results favored intensive phonics in 19 of the groups; three groups were not significantly different; no results exclusively favored gradual phonics. It was concluded from the subjects' performance on reading comprehension and spelling measures that the gradual approach to phonics is significantly less effective than the intensive approach at the start of reading instruction.

Among those who opposed this early intensive phonics instruction in favor of what is termed the intrinsic approach to phonics instruction was Russell (1963) whose research suggested that a moderate amount of phonics is helpful in learning to read and that a phonics analysis program must be intrinsic.

As in every debate there are those who advocate a truce. Winkley (1971) proposed an "intensive-gradual" phonics approach which strikes a happy medium between the intensive and the gradual or intrinsic approach. Winkley delineated substantive reasons for her recommendation and concluded that there is no logical reason that an analytical method, which has been termed a "meaning-emphasis," "intrinsic," or "gradual," approach cannot and should not also be an intensive, systematic code-emphasis approach. Although it must necessarily be gradual in its introduction of phonics principles, this fact does not preclude an intensive attack on teaching the clues once they are introduced.

Bagford (1971) favored the approach recommended by Winkley and urged synthetic emphasis in the beginning and then an early shifting to comprehension.

Summary of phonics literature. Authoritative statements and research reports all support phonic analysis as an essential tool for readers. Phonics is one of the word analysis skills that aids a reader in gaining reading independence; for it appears that without proficiency in phonic analysis many readers will never master the higher level reading skills.

Teacher knowledge and training in phonics. Since it is a fact that phonics commands an important place in the reading program, it follows that phonics needs to be taught well. This fact implies that good phonics teachers are needed. Popham (1965) posited the axiom that it must be a necessary assumption of teacher education programs that the knowledge, skills and attitudes acquired by a teacher candidate during his preservice training will influence his subsequent teaching actions. Barnes (1967) believed that the first requirement of a teacher is mastery of the discipline. He cautioned that nothing substitutes for subject-matter competence, rigorously developed and conscientiously updated. Durkin (1971) summed up the ideas of most educators as she pointed out that one cannot teach what one does not know. In addition, Durkin (1970) listed a teacher's knowledge of phonics, coupled with his ability to teach it to others as a definite contributing factor to a learner's success in phonics. She further alleged (1971) that if a teacher knows the content of phonics he [the teacher] will not be burdened with many of the questions relating to how much phonics and in what order.

Historically, (Gans, 1964) teachers have expressed feelings of inadequacy about phonics instruction. As early as 1929 supervisors reported that teachers showed great uneasiness in teaching phonics and complained that there was an insufficient amount of material on teaching phonics in their teacher-preparation courses.

Cordts (1955) became aware of the problem of inadequately prepared teachers at the outset of the phonics revival. She stated:

> It is not phonics that is being overlooked, but the teacher's inability to teach it intelligently. Students are being graduated from our teacher-training institutions without knowledge of the science of phonetics, or its application to the teaching of reading. It is little wonder then that phonics is among the most poorly taught subjects in the elementary school [p. 81].

In close time proximity to Cordt's statement, Dolch (1957) hypothesized that some teachers are opposed to phonics because they do not know any phonics themselves. Durkin (1971) discovered around that same time--1957--that her college seniors in reading methods courses did not know phonics content. She had supplied them with a proliferation of techniques and strategies only to find that the students had no content to fit into the techniques. She assumed that these limitations would not be present among experienced teachers; but, after sessions with them she found that she had misjudged their knowledge. The experienced teachers did not know phonics content either. In a national survey in which 603 teachers were administered the Phonics Test for Teachers, Durkin looked closely at the scores of the 204 who were experienced teachers. She found these data:

1. Eighty-nine percent could identify long vowel sounds.
2. Eighty-one percent could recognize short vowel sounds.
3. Only 29 percent could give explanations for vowel sounds.
4. Ninety percent could identify the hard and soft sounds of c and g but only nine percent could describe the conditions under which they occurred.
5. Very low percentages of correct responses were found to test questions about digraphs and diphthongs.

Schubert (1959) also questioned the knowledge of elementary and secondary teachers in the area of phonics and structural analysis. He investigated the knowledge in this area of 80 elementary and 41 secondary teachers in order to answer the question of how much phonics teachers knew. He reported that many of these teachers did not possess sufficient knowledge of certain basic principles of word analysis and inferred that such teachers offered minimal assistance to students who encounter words that are outside their [the childrens'] sight vocabulary.

Farinella (1960) agreed with the assumption of educational authorities that teachers must have a thorough knowledge of a particular skill before they can successfully teach that skill to a group of pupils and appraised the knowledge of phonetic and structural analysis of primary and intermediate grade teachers from liberal arts and teachers colleges. Several variables--years teaching, degree held, number of reading courses--were correlated with phonics knowledge. No significant relationships existed between phonics knowledge and any of the variables. Farinella concluded that a majority of the teachers tested showed a marked weakness in their knowledge of phonetic and structural analysis skills.

Aaron (1960) administered a test to 293 teachers on eight principles of phonics that are ordinarily taught to children who are working with basal readers on second- and third-grade levels. Some of the examinees were experienced teachers; others were without experience. All 293 subjects were enrollees in introductory reading courses. The group answered correctly 57 percent of the items. Though no standards were established, Aaron concluded that few teachers are well-grounded in the basic phonics principles. He believed his findings generalizable to similar groups enrolled in the teaching of reading courses.

The previously cited investigation by Austin and associates (1961) in the total area of teacher training in reading reinforced the theory that teachers do not know the techniques of phonic analysis.

They reported that college supervisors and cooperating teachers found that a lack of understanding of phonics principles was the greatest deficiency of student teachers in reading. This group of experts recommended that college instructors take greater responsibility in making certain that their students have mastered the principles of phonics and structural analysis.

Ramsey (1962) sought to determine the extent of the understandings, skills and concepts of preservice elementary teachers in five teacher education institutions in the midwest at the beginning of the reading methods course. An 85-item test was administered to the 236 subjects. The results led to these conclusions:

1. The common sounds represented by consonant letters were known.
2. The group was weak in determining whether the vowel sound in a word was long or short.
3. The group was weak in determining vowel sounds in unfamiliar syllables.
4. The group was weak in verbalizing the important principles of word recognition.

Further confirmation of the collective concensus that teachers' phonics knowledge is inadequate is given by Broman (1962) who investigated the factors associated with teacher knowledge of reading skills. The phonics content needed by teachers in the classroom was determined from a grouping of skills common to ten basal reading series. From these skills, an instrument appropriate for measuring teacher knowledge of phonics was developed. It was found that a significant number of teachers showed a marked deficiency in the phonics skills they would have to teach if they used the basal readers.

Spache and Baggett (1965) commented on the seriousness of a teacher who lacks knowledge of phonics and syllabication. They posed the question of whether teachers who do not understand the basic phonics principles can be relied on to teach phonic analysis well. The investigators hypothesized that the extent to which teachers can and do teach pupils various phonic analysis and syllabication skills is dependent upon their own knowledge of the underlying principles and conventions.

More recent investigations of pre and inservice teachers' knowledge of phonics, sanctioned by replication, the findings of Schubert (1959), Farinella (1960), Aaron (1960), Ramsey (1962), Broman (1962) and Spache and Baggett (1965). Two reports by Ilika (1967, 1969) dealt with teacher comprehension of vowel generalizations and differences in knowledge between males and females, respectively. The significant research question (Ilika, 1967) was: "How well do teachers comprehend vowel principles in relation to the utility of the vowel phonics principles as designated in Clymer's[2] research?"

The groups were comprised of geographically heterogeneous subjects with varying experience backgrounds. In the 1962-64 sample group, the subjects were all graduate students; in the 1965-67 sample group, the subjects were graduate students, undergraduates and seniors. The subjects were administered the Aaron Vowel Phonics Test which measures knowledge of the principles related to soft and hard c, vowel sound modified by r, vowels in open syllables, soft and hard g, short words ending in e, vowels in closed syllables, vowels followed by l and vowel digraphs. The percent of the utility of each principle as determined by Clymer's investigation, was then compared to the percent comprehended by the teachers. The resulting evidence suggested that teachers comprehend the less useful vowel phonics generalizations more than they do the useful phonics generalizations. The researcher (Ilika, 1967) inferred that if children are taught principles of low utility, frustration and waste of time are likely to result.

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[2] See T. Clymer. "The Utility of Phonic Generalizations in the Primary Grades," in M. A. Dawson (compiler) Teaching Word Recognition Skills. Newark, Delaware: International Reading Association, 1971, pp. 83-89.

Fleming (1972) utilized a unique assessment procedure for determining teacher understanding of phonic generalizations. He presented the 37 generalizations as they appeared in the Spache textbook (Spache and Spache, 1971) and asked the teachers to respond with a word which illustrated the generalization. The specific objective of the study was to determine whether or not a systematic relationship could be established between the reported utility value of the phonic generalization and a teacher's understanding of the generalizations with teacher's understanding being defined as the ability to respond with a word which accurately reflected the correspondence or intent of the phonic generalization.

It was hypothesized that the greater the reported utility value of the generalization, the greater the likelihood for obtaining accurate teacher responses. Conversely, for lower percentage utility generalizations, the less likely teachers would be to respond with accuracy. The findings supported the hypothesis; however, Fleming concluded that although some experienced teachers appear to know the phonics generalizations which are most consistent, it cannot be assumed that they know how to use this knowledge in teaching phonics. He also stated that the prospective teacher must have a secure understanding of phonics generalizations before teaching these generalizations to children.

Seymour (1969) noted numerous misconceptions that are held and practiced by teachers in their teaching of phonics which further reflected the inadequacy of preservice training. Of particular significance to the preservice situation in phonics proficiency of teachers is the study conducted by Taylor, Govatos and Lloyd (1971). They evaluated the impact and value of undergraduate reading courses as perceived by first year teachers. More than 67 percent of the teachers indicated that their preservice training in phonics and structural analysis did not prepare them to do a good job of teaching these skills. These ratings implied that beginning reading teachers do not feel qualified to teach phonic analysis to their pupils because they do not know phonics themselves.

The plight of the inservice teacher who attempts to build up her background by studying independently is explained by Aaron (1966). He pointed out that the process consisted of memorizing bits of information with little or no actual application. He advocated a more functional approach such as having teachers take time to work through exercises similar to those used with children.

Ramsey (1962) suggested that even if the teacher used the extensive plans for teaching phonics to children that are outlined in basal reader manuals, the teacher will encounter difficulty unless he has a command of the skills.

While the inservice situation reflects the quality of preservice training, more direct testimony to the inadequacy of preservice training in phonics is available. Piekarz (1961) criticized the global nature of reading methods courses. She saw them as dealing with reading in a general way rather than teaching specifiable skills or content. Teachers, she conjectured, have been impressed with the necessity of teaching phonics, but they have not been taught the elements of phonics. Phonics, she continued, is alluded to rather than taught.

Summary of studies dealing with teacher knowledge of phonics. The studies on teacher knowledge of phonics revealed that teachers, especially beginning and preservice teachers, do not know phonics content and have not mastered phonic analysis skills. It is agreed that the teacher must know phonics content and the techniques of phonic analysis if he is to teach the reader this technique of word analysis. Though some experienced teachers appeared to know more phonics content than inexperienced teachers, a teacher must have taught five or more years to learn an "acceptable" amount of phonics. Authorities concur that teachers should master phonics content and phonic analysis before going out to teach and that it is the responsibility of the preservice training program in reading to enable the attainment of such mastery. It was suggested that one functional approach to learning phonics would be to have the teachers work through and analyze words just as children must be taught to do. The major reason given for ineffective preservice training in phonics was that there was so much to be taught about phonics that there was not ample time in which to teach it.

Computer-Assisted Instruction Modes

Since the principles governing computer-assisted instruction (CAI) lend themselves well to providing individualized training in phonics for preservice teachers, the literature was surveyed for the ways in which the computer could be employed to teach in order to discern the most promising mode for teaching the phonics content to preservice teachers.

Computer-assisted instruction (Bloom, Hastings and Madaus, 1971) resulted from the convergence of two technologies: programmed-instruction technology and computer technology. Computer technology as it is now known is only a couple of decades old. Although there are many different systems of CAI, the basic ingredients are described briefly: a) A lesson to be taught is analyzed into the essential messages to the student; b) These messages are delivered through words, graphs, pictures, or any combination. Some messages may be auditory; c) As materials are presented the student reacts to them by answering questions, working problems, identifying points on a graph or objects in a picture, giving examples, requesting more information, or a chance to review messages presented previously, and so forth; d) Depending on the student's response, the computer presents the next message in the lesson, additional messages, ideas given earlier, a review of earlier messages of additional "developing" questions.

Computer-assisted instruction (Klaus, 1969) is the general term used to describe applications involving continuous interaction between the student and the computer during learning. Computer-managed instruction (Klaus, 1969) is the use of electronic data processing equipment to supervise the sequence of instructional materials.

CAI may be defined more specifically according to an identification of its activities, (Dick, 1969). There are five major instructional modes of computer-assisted instruction: drill and practice, tutorial, problem-solving, dialogue, and simulation.

In the drill and practice mode, sessions are extensions of the procedures used in the conventional classroom instruction. Drill and practice materials can be prepared at several levels of difficulty. The computer presents the materials to the student, examines performance and selects appropriate material. The computer system presents the drill materials to the student; the student responds through the terminal input devices. If a student's response is correct, he is informed; if it is incorrect, he is asked to try again. Cues are given to the student whose responses are wrong. If the student continues to respond incorrectly, the computer provides remedial work through a branching program. As correct responses are recorded, additional appropriate materials are presented. The drill mode (Klaus, 1969) presents a functionally linear sequence of practice items. The content of instruction most readily organized into a drill format includes arithmetic, spelling, second language vocabulary, and other stimulus-response oriented content.

In the tutorial mode of CAI, it is the computer which does the original teaching. Curriculum materials (Cartwright and Mitzel, 1971) are prepared and adapted to the system and then presented to the student through computer interface devices. This mode simulates the master tutor engaging in an interactive dialogue with an individual learner. The tutor presents information, asks penetrating questions, and carefully analyzes the learner's responses to the questions. On the basis of the learner's demonstrated understanding or lack of understanding of a given concept, the tutor provides alternative courses of instruction, remedial sequences of instruction or even enrichment material. The tutor can move a capable or well-informed learner through a course of instruction very rapidly. Similarly, the tutor can tailor a sequence of instruction to meet the needs of a learner who is not as capable or does not have a good background or experience or preparation.

The dialogue model, (Richardson, 1968) is likened to a question and answer session between a student and his teacher. In this mode, the conversation is guided by the computer within the limits of the information that have been established from the instructional materials of the subject area to be covered. It is necessary to specify limits to the vocabulary that the student may use in his dialogue with the system in order to establish a finite frame of reference within which the dialogue will take place, and for which the appropriate programmed instructional material can be developed for storage in the computer system. Then the conversation follows as closely as possible the natural content and the sequence of a discussion between student and teacher.

The problem-solving mode is perhaps the most direct use of the computer in the classroom (Richardson, 1968). Computational steps needed to solve problems are written into the computer in the form of commands. This list of commands comprises a program. Students input data and commands; the computer solves the problem and outputs the answers. Stolurow (1967) noted that the professor whose students use the computer to solve assigned problems needs to teach in the same way he has taught in the past. The problem solving mode is readily achieved, provided the typical computational capability of the computer is available and there is an electric typewriter, or some other display and response device, in two-way communication with it. In addition, the student needs to know how to communicate with the computer and how to solve his problem. Each student must know a language that permits him to enter into the system both the data for his problem and the steps which the computer is to take in working out the solution to it.

The simulation mode (Hickey, 1968) is described as the use of the system to provide practice in situations that are similar to situations likely to be encountered in the future. The computer responds just as the simulated product would react. In this mode (Stolurow, 1967) the instructional staff formulates a model of some real, or idealized complex situation such as the operation of a chemical plant or the management of a company. With a simulation the variables are defined by the specific situation. A computer program has to be written to process the student's input so that meaningful information related to his actions comes out. The output is determined by what the student does as compared to the model. In this mode the student uses his initiative in reacting to the system.

Summary of modes for computer-assisted instruction. The CAI system offers several modes for presenting and handling information.

The use of one mode does not preclude the use of another. A system may well employ an intermixing of the types or modes discussed. It is usually found however, that one mode is used predominantly because the nature of the content to be accommodated adheres more to the features of a particular mode than to another. The drill and practice mode appears most efficient for presenting stimulus-response material; the problem-solving mode is used chiefly to process technical problems in such areas as mathematics and chemistry according to a program. The simulation mode is the use of the system to effect situations wherein the learner must react in a logical manner. Examples of such situations include a war, business management and so forth. The dialogue mode is an open-ended approach in that the areas for investigation are made available to the student and the student asks questions about the topic at hand. The student learns what he chooses to learn for there is no prescribed program. The tutorial mode is that mode in which the computer presents, controls and sequences the information based on the individual student.

Computer Assisted Instruction: Course Development and Evaluation

Because the objectives of this research project were to develop, test and validate a CAI phonics course for preservice teachers in order to determine the effectiveness of the course, the literature was surveyed to find out how a CAI course is developed and how it may be evaluated.

The literature revealed that a complete CAI course is taken through at least two cycles: the product development cycle and the validation or evaluation cycle. The steps in CAI development are illustrated in the first three reports. Information on and suggestions for validation/evaluation comprise the remainder of the section.

CAI course development. Popham and Baker (1971) divide the product development cycle into seven stages. The first stage is called the "formulation stage" where decisions are made regarding social utility, cost and availability of competing products. They established that the extensiveness of the product should be commensurate with the product's importance and that there should be no competing products of high quality. Stage two--the "instructional specification stage"--deals mainly with objectives. It is during this stage that instructional objectives are spelled out and that prerequisite behaviors are identified. The researchers asserted that the objectives must be stated in terms of post-instructional behaviors.

The "item tryout stage" is designated as stage three. Items which measure the terminal and other behaviors are administered to a group of learners typical of the target group. The test items are "tried out" to be sure that learners possess the necessary entry behaviors, and do not possess the terminal behaviors. It was mandated that criterion tests be developed prior to the development of the instructional product; and it was suggested that the items should be first "tried out" with a small number of learners and later with a larger number.

The fourth stage is the "product development" stage; it is that stage at which materials are actually prepared for the learner. Several rules were prescribed for this stage: the learner should be supplied with appropriate practice during the instructional sequence;

the learner should be provided with knowledge of results; inflexible strategies should be avoided; and selection of the instructional medium should be made in light of the desired instructional objectives.

The point at which the developed materials are used extensively with groups of learners is labeled the "product tryout stage." During this stage, the authors ruled that extremely large or extremely small numbers of learners be avoided when field testing, that the procedures be verified as replicable, that data from field tests be efficiently summarized and that the researchers in the field testing phase collect data rather than draw inferences.

The "product revision stage" is that phase in which the results of the field trial are used to improve the instructional product. The revisions should be based on legitimate inferences from field test data which include terminal criterion data and in-course learner response data.

The final stage in product development, as viewed by Popham and Baker (1971) is the "operations analysis stage." It is at this point that the product developer undertakes a systematic operations analysis of every completed product. This analysis would cover the strengths and weaknesses of the process and product. The analysis should then be transmitted to some central repository for subsequent examination. The statements on product development offered by Popham and Baker have been realized in the course development schemes of the two projects which are chronicled below.

Walter (1965) outlined a course used to train experienced teachers to author CAI course modules. These steps were actually followed when the teachers developed the Individualized Learning Modules used to teach topics in chemistry, physics, mathematics, social studies and foreign languages to high school students in Maryland. A summary of the procedures is outlined without discussion:

- A. Module Design [those steps involved in planning and structuring the basic framework for a module]
    - 1. selecting a topic
    - 2. defining the terminal objectives
    - 3. constructing a learning hierarchy
        - a. task analysis
        - b. enabling objectives
        - c. ordering objectives
        - d. identifying entering behaviors
    - 4. developing criterion test items
    - 5. assembling an entering behaviors test and the pretest/posttest
- B. Module Development
    - 1. devising and flowcharting the instructional strategy
    - 2. selecting the presentation media
    - 3. writing the instructional sequence
    - 4. editing the draft and translating it to the presentation media
    - 5. testing the module with a small group of students from the target population
    - 6. revising the module based on feedback from the student tryout

C. Editing and Pilot Testing

1. editing of paper draft for accuracy, grammar, smooth and logical flow
2. translating to presentation medium by programmer
3. editing on-line by author and programmer
4. pilot testing with two or three students to discover the major flaws; first major author revising based on student records
5. trying out with small group of approximately five students who work through the course unaided; students record comments and the data from this group are used for last major revisions before validating and field testing

Gillikin (1969) at the United States Naval Academy, reported steps similar to those followed in Maryland (Walters, 1965) in the Academy's CAI 1500 Course Development Model. The Model, applied to the development of CAI courses at the Academy, is four-phased. The first phase involves course definition and organization where agreements on what constitutes the course and the scope of the course are reached. Terminal and interim objectives are written; evaluation instruments are developed; prerequisite topics are written. After the terminal and interim objectives are sequenced, the course is divided into modules and the manner in which CAI will be employed is decided.

The second phase--module development--constitutes the writing of course materials which include these kinds of materials:

pretest
teaching materials

diagnostic tests
check tests
drill and practice exercises
posttest
summary materials

Phases three and four encompass initial reviewing and testing of the materials. After the materials are converted to CAI format, entered into the computer, debugged and formed into modules, initial student testing takes place. Revisions are made based on performance records. After the testing and revising, the course development process ends. Then the course is ready for the next necessary step: validation.

Summary of CAI product development studies. The studies and sources dealing with CAI product development emphasize these as the major steps in course development: a) selection of topic; b) development of scope and sequence of instruction; c) specification of terminal objectives; d) development of criterion test items; e) development of course materials for the CAI system components; f) translation of course materials to CAI medium; g) course revision; h) pilot testing; and i) revising and retesting.

CAI validation/evaluation. Though the term evaluation is often used synonymously with validation, the two terms differ qualitatively. In CAI course validation, steps are taken to determine to what extent the learning module or course does what it was designed to do. Evaluation generally refers to a comparison in which the results of the module or course are compared with results of instructional strategies employing other practices, procedures or materials. Accordingly, the reports that follow focused on validation, sometimes referred to as developmental evaluation or formative evaluation, since the purpose of this project was to develop and validate a CAI course and no summative evaluation was intended.

Brennan (1969) provided an overview of techniques used in formative evaluation or validation of instructional programs that began with use of expert opinion. Subject matter experts judge the appropriateness and correctness of program objectives, tests and content; then preliminary testing occurs. From this preliminary testing, the evaluator obtains data on program effectiveness with a small number of students. Brennan found various suggestions regarding the total number of students to use in the preliminary testing and he concluded that the recommended optimum number of students to use is about 10. He pointed out that when a program has been tried on about 10 students and revised after each student's responses, the program should work satisfactorily with 98 percent of the students from the same population.

Brennan (1969) also noted that there are no standardized tryout procedures, but that in general, the programmer and student go through the program frame by frame making notes of needed changes. After the initial evaluation, the instructional program is usually field tested under conditions approximating those for which the program is intended. During the field-testing phase, a program is usually revised two or three times until the data indicate that the program has met the predetermined, cut-off points for validation. The number of students that should be used in field testing is unresolved according to Brennan (1969) as is the number of students to be used in the preliminary testing. However, Brennan's overview of the recommended numbers showed that from 15 to 30 students are suitable depending on the projected population size.

At least five different suggestions for validation criterion were reported: (Brennan, 1969)

1. The criterion level for validation should be 90/90 [Ninety percent of the students should attain 90 percent of the terminal objectives].
2. The criterion level for program validation should be 80/90.
3. A predetermined gain ratio should be used to validate the program. The gain ratio is the ratio between the amount learned and the amount that could be learned.
4. A modified gain ratio should be used in program validation. The modified gain ratio considers the student's pretest knowledge.
5. An error rate of less than 10 percent should be the criterion for program validation. The error rate is the average percentage of errors on all frames for all students. The lower the error rate, the more reliable the course.

The flowchart suggested by Brennan for program evaluation is presented on the following page:

The next two validation plans were used in validating the CAI projects cited previously (Gillikin, 1969; Walters, 1965).

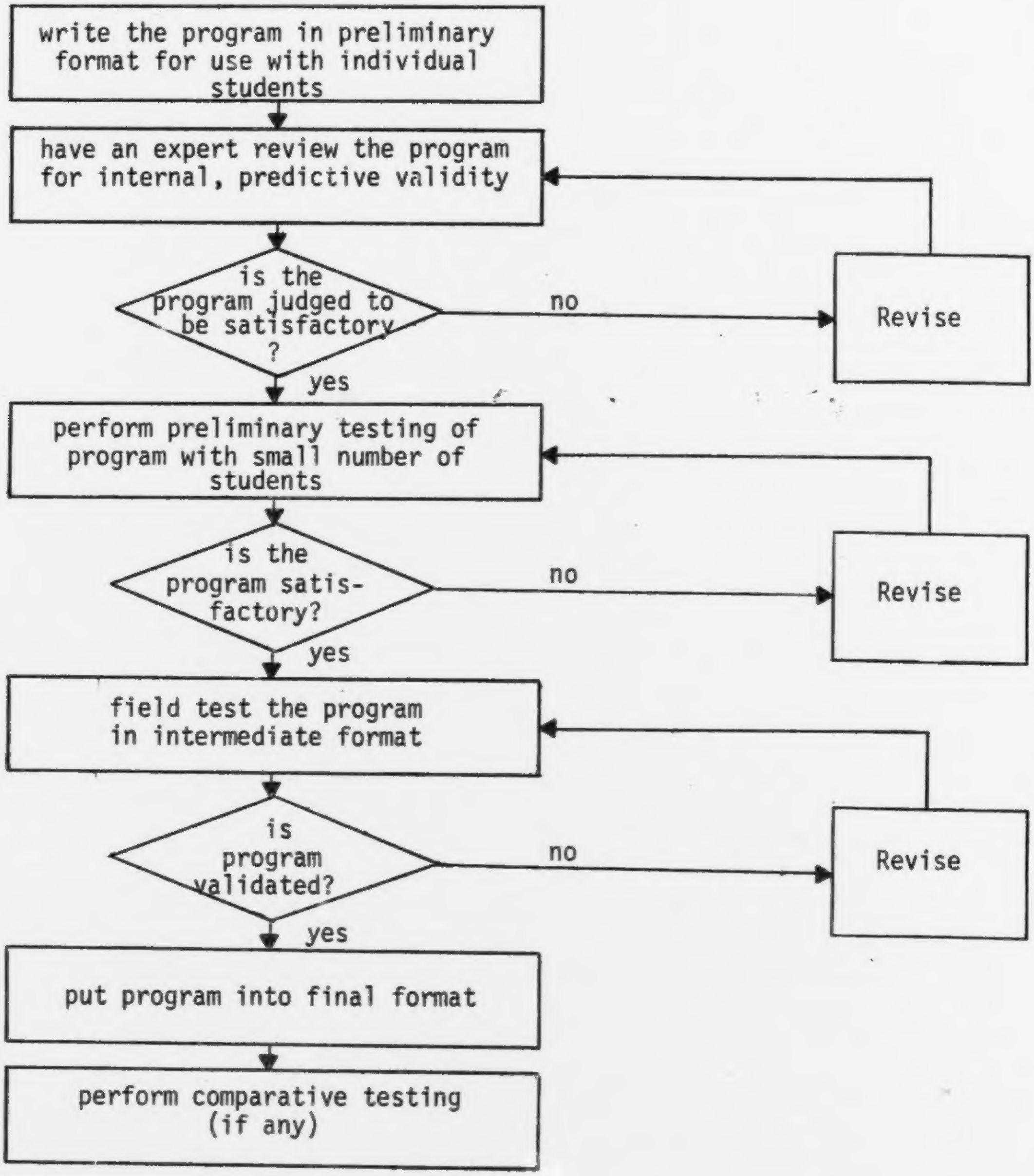
write the program in preliminary format for use with individual students
have an expert review the program for internal, predictive validity
is the program judged to be satisfactory ?
no
Revise
yes
perform preliminary testing of program with small number of students
is the program satis-factory?
no
Revise
yes
field test the program in intermediate format
is program validated?
no
Revise
yes
put program into final format
perform comparative testing (if any)

Fig. 1. Flowchart for program evaluation; (adapted from Brennan, 1969).

The purpose of the validation plan by Gillikin (1968) was to determine whether or not the course materials written by the author and programmed by the technical staff accomplished the objectives of the course. Two types of validation were achieved with the developed modules. Content validity, the validity demonstrated by showing that an instructional program actually contains the information which it was supposed to contain as stated before course development, was based on expert judgment. The second type of validation, formative validation, was based on criterion-referenced testing and the previously established criterion level for validation. If the CAI presentation did not meet the specified level for validation, the teaching materials were reviewed and revised until the criterion level was obtained.

These data were collected for validation and analysis:

A. previous test scores (background data, SAT-verbal, SAT-mathematical, from the College Entrance Boards Examinations, rank in graduating class) were gathered for correlation with achievement and time to complete the course

B. student comments

C. date, sign-off label and total time for each student recorded at the end of each session

D. student performance records for each student which included: time of day, student number, course name, date, ep identifiers, response identifiers, actual response, response latency, counters and switches[3]

The validation data were processed initially by extracting student performance records and placing them on a course master tape. The master tape was then sorted by module number, ep identifier and student number. All comments and all unanticipated responses were extracted and printed. The author then reviewed comments and unanticipated responses and revised and updated accordingly.

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[3] These terms are important to understanding the data gathered in the validation studies: a) Segment - a logical part of a course; b) EP Identifier - a label indicating to which frame, problem or question a student is to respond; c) Response Identifier - an entry in a scheme which indicates whether the student's response was correct (ca), incorrect (wa), unanticipated (un), not given (nx), second wrong answer (wb), partially correct (cb) and so forth. The response is analyzed by comparing it to the answer set (all anticipated answers, correct or incorrect that have been programmed into the course) and determining into which category the given response falls; b) Label - the name given to a small part of a course, such as a frame or problem, for the purpose of referencing that particular part of the course; Student Records - the information accumulated by the computer about a student's performance while taking a course; Counters - a storage area accessible by a course in which simple arithmetic operations, such as addition and subtraction, may be performed; e) Switches - a storage area of the computer in which can be stored a zero (0) or a one (1), zero indicating an "off" condition and one indicating the "on" condition, thus making it possible by loading a switch to know whether a certain point in the course was passed, whether the student responded in a certain way, and so on; f) Response Latency - the duration of time between a presentation of a problem to which a student is to respond and the entering of the response by the student; g) Actual Response - the response that a student makes to a question or problem in a course; the actual answer, what the student did, is recorded.

Secondary processing of the validation data included these steps:

1. Updating of data on course master tape
2. Generating student response matrix
3. Summary of student response matrix
    a. total questions tried
    b. total pretest questions correct
    c. total posttest questions correct
    d. ratio of total questions correct to total questions tried
    e. ratio of pretest correct to pretest tried
    f. ratio of posttest correct to posttest tried
    g. percentage of maximum possible gain
    h. rank according to total posttest questions correct
    i. rank according to percentage maximum possible gain
    j. number of pretest, posttest, check test and diagnostic items
    k. percentage of students attaining a certain percent of correct posttest answers
4. Item Analysis Chart
    a. number of persons with a particular question correct or wrong
    b. mean and standard deviation of latency
5. Student Progress Chart
    a. progress by class session
    b. progress by time

The validation sub-plan prepared by Goding (May 1, 1969) for the Montgomery County CAI Project followed much the same procedure as that of the U. S. Naval Academy (Gillikin, 1968). This validation plan, as was the U. S. Naval Academy's, was concerned primarily with content validity and criterion-related validity.

The criterion levels for validation were established: 90 percent of the students would meet 90 percent of the criterion test items. The following data were collected and analyzed: time of day, student number, course number, date, ep identifier, response identifier, latency time, counters, switches, comments, date, sign off, label, and total time for each student.

In addition, two validation charts were generated. Validation Chart A had these columnar headings: ep identifier; number tried/number presented; difficulty level 1 - number correct/number tried; difficulty level 2 - number correct/number presented; discrimination index; maximum, minimum, mean and standard deviation for latency time. Validation Chart B was organized to contain these data:

Number of pretest questions tried
Number of posttest questions tried
Number of diagnostic questions tried
Number of instructional questions tried
Percent of students
Percent correct for pretest

Percent of students
Percent correct for posttest

Percent of students

Percent correct for instructional

R Pretest

R Posttest

R Diagnostic

R Instructional

Maximum

Minimum

Mean Total Time of Modular Instructional Packages (MIP)

Standard Deviation (S. D.) of Total Time on MIP

From the collective data on the validation charts, the authors determined which posttest questions were below the criterion level, which revisions were needed, which questions were not being used and if criterion level for validation had been reached. Documentation of validation (Walters, 1965) was to include the number of persons tested, the description of the target population, the minimum acceptable standard for validation, the percentage of attainment, the method used to validate the hierarchy, the results of the evaluation and the mean time to completion for the module.

Summary of information about validation studies. The validation studies cited above suggest that there are at least five principal considerations for course validation. These include: a) establishing a criterion level for validation; b) selecting a validation sample typical of the population of concern; c) formulating a validation plan; d) collecting significant validation data and; e) analyzing the data to determine if the criterion level for validation was met.

Comparative evaluation for CAI courses. The use of CAI in comparative studies remains an issue. Even during the inchoate stages of CAI development, researchers cautioned others about making comparisons. This study focused on formative evaluation and tested the effectiveness of the developed CAI course for preservice teachers. Since, however, comparative CAI studies have maintained some prominence in the research literature, an overview of current views on comparative CAI studies was justified.

The education research question of the past which asks whether a particular new method results in more learning than a traditional method has been criticized by Stolurow (1962) because the critical factor of a representative sample of the method may not have been representative. Stolurow (1962) asserted that the real question is efficiency and not amount of learning. His feelings on comparative CAI studies are illustrated in his prediction that the comparative study will be expunged from future research on auto instruction. He avowed: "My prediction and firm hope is that the comparative study in which a teaching machine is compared with live teaching will become extinct [p. 521]."

Brennan (1969) in his literature search for CAI comparative studies, found that a well-conducted comparative study is a rare occurrence. He maintained that comparative testing is not essential for evaluating the effectiveness of a program and that comparative testing very often produces meaningless results. He holds the position that without dependable and acceptable criteria of program effectiveness, there can be little program quality-control; nor can there be any objective basis for comparing one version of a program with another version, let alone comparisons between different programs. He cited these seven criteria for comparative studies:

1. prerequisite variables
2. identical content, objectives, concepts, examples, illustrations and learning activities
3. optimum learning conditions
4. unbiased criterion
5. extraprogram factors
6. matched or random treatment groups
7. replication

He suggested that comparative studies be used to answer questions about cost, or effectiveness of particular programs in a given situation with a specified target population.

Two fundamental criteria for comparative studies have been established by Feldhusen and Szabo (1969a) as: a) specification of objectives and use of the same objectives by methods being compared; and b) specifiable and reproducible instructional events. That these criteria were not met in previous comparative studies is implied in Feldhusen's and Szabo's assertion (1969a) that the research is of poor quality and poorly reported. The reasoning behind the assertion may be attributed to the situation observed by Feldhusen and Szabo (1969b) that the unpublished literature dominates the communication among researchers and developers in programmed instruction (PI) and CAI so that few things are published in scholarly journals of comparable copyrighted sources.

Walter (1965) viewed comparative studies which pit the results of CAI against results of other practices, procedures or materials as feasible if based on sound research procedures. No specification of these procedures was made by Walter.

In spite of the mass of opposition, many CAI instructional programs are compared with traditional or ongoing methods of instruction (Feldhusen and Szabo, 1969a). At least half of the studies reviewed had as the major emphasis some comparative evaluation with traditional instruction (Proctor, 1969; Kromhout, Hansen and Schwarz, 1970; Roid, 1971; Grandey, 1970).

The so-called traditional research question may have maintained some status possibly because, as Feldhusen and Szabo (1969a) so aptly pointed out, the very thing which school people want to know is how well the new method works in comparison with what they are doing.

Summary of information relating to comparative CAI studies. The literature reveals that educators and laymen alike are interested in how well CAI compares with 'traditional' instruction. CAI authorities point out that few comparative studies which pit CAI against some traditional method of instruction fully meet the criteria for quality comparative studies. Many CAI authorities maintain that effectiveness studies should receive the emphasis in CAI research. It was suggested that the most significant contribution that comparative CAI studies can make is to compare the economics of CAI to CI.

Computer Assisted Instruction: Research Projects

CAI's effectiveness has not been investigated in all disciplines with all learners, in all environments. There are however, many reports on developed projects which attest to the fact that computer-assisted instruction is feasible and effective. The CAI projects described in this survey met two criteria: they dealt with subjects at the high school level or above; and they employed the tutorial mode predominantly. The projects are described in this order: 1) those whose main focus was developmental or formative; 2) those which employed both formative and summative evaluation.

Developmental CAI projects. Mitzel, Brown and Igo (1968) used computer-assisted instruction in a recognition course about malarial parasites to test CAI's effectiveness in teaching a technical medical subject. The scope and sequence of the course content were developed from the behavioral objectives of the course. The main objective was to enable the learner to make a diagnosis of the presence or absence of malaria after studying microscope slides containing thin smears of the patient's blood. The instructional segments followed a tutorial format and were labeled stage discrimination, species identification and discrimination and diagnosis from case history. A preliminary evaluation employing 20 subjects was conducted at the National Naval Medical Center. Seventeen men and three women, either Navy hospitalmen, officers or civilians, comprised the group. Three criterion tests were developed to assess the performance of the subjects at the termination of the program. In addition to the three criterion tests, in-program performance recordings were collected on each student.

Upon completion of the program, the three criterion tests were individually administered. Student completion time ranged from four hours and 42 minutes to 12 hours and 39 minutes. The specific criterion level for validation was 90/90. The total mean scores for the subjects in the upper 90 percent of the group was:

Test 1	78 percent correct
Test 2	91 percent correct
Test 3	90 percent correct
Total	85 percent correct

Reliability estimates were obtained for the three tests by the Hoyt analysis of variance technique. Tests 2 and 3 were shown to have reliabilities of .92 and .84 respectively. Test 1 was found to have a reliability of .51.

It was concluded that the present form of the program performed well. Discounting Test 1, the 90/90 criterion was met. One plausible explanation given for below criterion performance on Test 1 was that the photographs used in the corresponding instructional segment gave less information than did the microscope slides.

The research design of the investigation was developmental since the researchers felt it was premature to suggest a carefully controlled comparative study in which CAI is pitted against some "so-called" conventional instructional format. It was suggested that the course be taken through several "optimization" cycles and hence improve the teaching power of the program.

Computers have assisted in the instruction of instrumental music. Diehl (1969) explored the feasibility of computer-assisted instruction for instrumental music by developing and evaluating a course in intermediate level articulation, phrasing and rhythm for clarinet. Because of the newness of CAI, a feasibility, or developmental approach was chosen rather than a more structured design such as the comparative study. Diehl found that high school students learned efficiently through the CAI mode and that CAI seems particularly well adapted for aural-visual discrimination training. One significant feature of the program involved student judgment in comparing his version with a model. The student heard a pre-recorded master model, played and recorded his version and then heard an instant comparison of the model and his recorded version. If he felt he matched the model satisfactorily, he proceeded to the next frame; if he wished to hear the comparison again he pressed repeat. The student could also record his version again and make another comparison with the model. Diehl saw this feature as a valuable part of the learning experience.

The criterion levels were established for the respective checkpoints which were positioned throughout the program. If a student did not meet criterion, he was branched to remedial segments. Since listening requires an attentive set which may be jeopardized by momentary lapses, this position for in-course criterion testing was considered more suitable than other positions.

Approximately 19 months after initiation of the project, the pilot trial with 14 pupils began. The students in the sample were high school clarinetists who were beyond the beginning level. Two types of performance records were obtained: student-oriented records gave chronologically ordered performance information for each student; course-oriented records listed information in the order of question identifiers.

Student completion time ranged from six hours, 21 minutes to 11 hours, 25 minutes. Diehl's staff constructed an item response analysis chart which indicated right or wrong responses. The actual frequency of attempts and number of errors for each item were shown on another chart. Information on the course-oriented records for each frame included these items: course segment, student number, frame identifier, response latency, response identifier, date, time of day and frequency of attempts. Tables were generated which indicated student time in hours and minutes to complete the aural program. Revisions in the main flow of the course were made from the analysis of student errors. Questionable items were reviewed and in some cases deleted. At some points, the instructional blocks were completely restructured. Remedial materials were revised in the same fashion.

Yens (1969) developed and evaluated a computer-based pure tone audiometer trainer. Research findings revealed that the computer was effective in teaching students with varying degrees of experience to produce acceptable audiograms. Seventy percent of the learners met the criterion of producing "acceptable" audiograms. A developmental rather than a comparative design was viewed as more suitable to the study.

Hall, Riedesel, Suydam, and Trueblood (1970) field tested a program of inservice education in modern mathematics and mathematics teaching methods for elementary teachers in the Appalachian region.

The investigation was based on the widespread agreement that a critical need existed for new methods of providing quality inservice mathematics instruction. It had been determined that preservice and inservice mathematics training programs were inadequate and was concluded that a computer-based program in modern mathematics was the best choice for accelerating the accessibility of quality inservice education for mathematics teachers in Appalachia.

The target population consisted of teachers of elementary pupils in sparsely settled areas of Appalachia. An IBM 1500 instructional system was installed in Dryden, Virginia, Gladeville, Virginia, and California, Pennsylvania, in that order, to administer the computer based course to the teachers. This system was used during afternoon and evening hours to provide individualized instruction for the teachers.

Of the 444 students who registered for the course, 387 completed the program. The average completion time was 19 hours. The minimum clock time for the fastest students was 12 hours with the maximum completion time being 56 hours. The "Test on Modern Mathematics," developed by the authors, served as pre and posttest criterion measures. The authors believed that the population of elementary teachers should be expected to achieve a mastery level of about 90 percent after instruction.

Students at the three locations increased their median achievement from approximately 50 percent to about 75 percent after a seven-week period of concentrated instruction via CAI.

CAI developmental and comparative studies. CARE 1, Computer-Assisted Remedial Education: Early Identification of Handicapped Children, was developed (Cartwright and Mitzel, 1971) to prepare inservice teachers of regular grades to identify and adequately diagnose conditions in children which may adversely affect their school performances. The developers of CARE 1 maintained that the majority of inservice teachers had not had the opportunity to acquire adequate information about the possible deviations in behavior that influence learning. They further contended that teachers need adequate information in order to make appropriate educational decisions. The course, deemed appropriate for teachers of all grade levels, was specially designed for preschool and elementary school teachers. The course development procedure included: a) refining and expanding the course description; b) specifying behavioral objectives for course segments and frames; c) authoring of course materials; d) preparing course material for the CAI system; e) testing and revising the course; and f) documenting the course.

The CARE 1 course was initially tested by staff personnel to assure a smooth and logically flowing course. The first pilot testing was carried out with 15 students during the summer, 1970. These students were accompanied by proctors who recorded students comments and program "bugs." Revisions were made based on these students' comments and author analysis of student records. The second pilot group, consisting of 15 additional students, was assigned to the course in late summer, 1970. The same procedure was followed for the second pilot group except that the students recorded their comments without the aid of a proctor. Two advanced graduate students were students in the course in the fall of 1970 and followed the same recording procedures. These students also compiled a detailed evaluation of all the segments with special emphasis on the objectives.

CARE 1 is alleged to be a thoroughly documented course. This means that there exists a complete printed version not only of course content and strategies, but of other more specialized types of information. Course documentation information is in three sections in CARE 1. Section 1 consists of representations of screen (CRT) displays; Section 2 contains the coding section and Section 3 is a complete cross-reference table showing which audio messages, buffers, functions and so forth were used and where they have been used with respect to course labels. Other forms of documentation are a 400-page Handbook and a course Syllabus. The Handbook contains detailed summaries for each chapter, a 350-item glossary of critical terms and a comprehensive course outline. The Syllabus contains a description of the purpose of the course and an outline of course content and objectives.

CARE 1 was evaluated in two ways: formative evaluation for program development was followed by summative or comparative evaluation. During the formative evaluation, professional consultants reviewed the course. When the course was deemed operational, pilot groups were used for testing and revising the course. The second evaluation (Cartwright, Cartwright and Robine, 1972) was summative. During the winter term of 1971, all students (N = 114) enrolled in the course Education of Exceptional Children (EEC 400) at The Pennsylvania State University were randomly assigned to either of two conditions--computer-assisted instruction or conventional instruction (CI).

The CAI group (N = 27) received all instruction by means of the IBM 1500 Instructional System and did not attend classes with the CI group. The CI group (N = 87) received the conventional lecture-discussion method of instruction and met three days per week in 75 minute sessions for ten weeks. All students were enrolled as regular students for three credits. Both the CAI and CI courses were designed to enable students to achieve the same objectives. The instructor of the CI group was an author of the CAI course and helped to plan the structure and the objectives for the CAI course.

The data (Cartwright, Cartwright and Robine, 1972) indicated that the students instructed by CAI obtained a mean score 24 percent higher on the criterion test than did the CI students. The differences between means of scores on the criterion test was significant with $p < .001$. On the average, CAI students completed the three-credit course in 12 hours less time than the time (37.5 hours) scheduled for the CI students.

A CAI developmental-comparative study was undertaken by Ehlers (1969) with social work students. Ehler's first goal was to test the feasibility of CAI for teaching prerequisite behavioral sciences knowledge. Programs were written in sociology, psychology, child development and Freudian concepts. Faculty members in the areas reviewed the programs. The feasibility study resulted in programs which were used with 113 first-year students in 1967. These students agreed that they remembered the facts that were reinforced in CAI.

In September 1968, an updated version of the program was used in a comparative study in which one half of the group was instructed via CAI; the other half through regular instructional techniques. An analysis of variance was used to test the assumption that randomization divided the student body into two comparable groups and that there was no initial significant differences between groups. While there were no statistically significant differences between groups, mean gain scores were higher for the CAI group on all posttests. Ehlers believed that the trend of higher CAI group scores inferred that with future CAI groups there would be positive statistically significant differences, given that more instructional time was allowed and improved programs were available.

Summary of CAI studies. Computer-assisted instruction has proved effective in a wide variety of content areas at the high school and college levels. These areas include music, audiology, education of exceptional children, mathematics, medicine, curriculum, physics, psychology and chemistry. In those courses which concentrated only on course effectiveness, CAI proved effective at the desired level, for the most part. In those studies which compared CAI with another mode of instruction, CAI proved either more effective or just as effective as the alternative mode of instruction. With most of the courses, developmental steps similar to those suggested and followed by Walters (1965) and Gillikin (1969) were employed. Courses were first developed and tested for effectiveness. Comparative evaluation, if any, followed only after effectiveness was proven.

Criterion-referenced Measures and CAI

The one point on which CAI spokesmen agree, without exception, is that criterion-referenced measures should be used to assess learner achievement in CAI courses. Because of the universality of opinion toward criterion-referenced measures for CAI the current literature was surveyed to answer these three questions: 1) How are criterion-referenced tests developed? 2) What statistical indices are appropriate in evaluating criterion-referenced measures? and 3) What are the relevant attributes of criterion-referenced tests. The answers to these questions were needed to provide guidelines for the researcher in incorporating criterion-referenced testing in course development.

Today, commercially available standardized tests, with few exceptions, are norm-referenced; they measure inter-individual differences in achievement. The changing trend is voiced by Airasian and Madaus (1972) who alleged:

> The last three or four years have witnessed a growing interest in criterion-referenced measures, particularly in the classroom context. The interest is predicated upon a series of trends occurring both inside and outside education [p. 2].

Most significant among the trends which stimulated the interest in and use of criterion-referenced measures has been the growth of instructional technology. Norm referenced tests did not meet the instructional technologists' needs for evaluating either individual performance or program effectiveness. Consequently, an instrument which used program objectives as performance standards had to be used. The criterion-referenced test was that instrument.

Airasian and Madaus (1972) described the conventional steps in implementing criterion-referenced measurement as:

1. develop, prior to instruction, a list of terminal behavioral objectives in performance terms.

2. set a standard for each objective as well as a standard for the complete set of criterion behaviors.
3. devise situations which allow the students a chance to exhibit the desired behaviors.

Certain implications for criterion-referenced measures with respect to variability, item construction, reliability, validity, item analysis, reporting and interpretation were made by Popham and Husek (1969). The implications are listed without discussion:

1. With criterion-referenced tests, variability is irrelevant.
2. The item must represent the class of behaviors delimited by the criterion.
3. The typical reliability indices of internal consistency are not appropriate for criterion-referenced tests.
4. The most suitable type of validity for criterion-referenced measures is content validity which is based on careful judgment of the tests' apparent relevance to the behaviors legitimately inferred from the behaviors delimited by the criterion.
5. For criterion-referenced tests, an item which does not discriminate need not be eliminated. If it reflects an important attribute of the criterion, such an item should remain in the test.
6. When reporting and interpreting an individual's performance on a criterion-referenced test, group-relative

indices are not appropriate. In criterion referenced reporting, it is sufficient to report whether or not the learner has displayed the desired criterion behavior.

7. In using criterion-referenced measures to make decisions about treatments, the best course of action is to employ a number of schemes in reporting the groups' performance.

Popham (1971) in an effort to identify useful indicators by which a criterion-referenced item writer could judge the adequacy of his test items, concluded that the goal of the criterion-referenced item writer should be for his test items to accurately sample the range of criterion behavior which the items have been designed to measure.

The approaches to developing such test items have been labeled by Popham (1971) as 'apriori' and 'aposteriori.' In the apriori approach an item form, which constitutes a complete set of rules for generating a domain of test items which accurately measures a particular objective, is used. The aposteriori approach is viewed as the alternative to the apriori approaches. In the aposteriori approach, the test items are developed around whatever generation rules are available. The items are then "tried out" to discover empirically which items are not congruent with the criterion. Those items which are defective are eliminated.

The state of the art of criterion-referenced test development and evaluation was articulated by Jackson (1970):

> It appears that at the current state of the art it is difficult to develop the objective procedures necessary for criterion-referenced measurement of complex behavior without doing

> violence to measurement objectives. What is needed for complex domains are item generating rules that permit generalizations of practical significance to be made [p. 14].

The statement implied that for the moment, until explicit models for item forms are stated in measurable terms for criterion-referenced test development, a degree of subjectivity in test construction will prevail.

Implications and Conclusions from the Literature

Phonics instruction and teacher knowledge. The literature about phonics instruction, teacher knowledge and methods courses in reading implied or led to these conclusions:

1. Phonic analysis is an important component of both beginning and on-going reading instruction.
2. Teachers, both pre and inservice, show some deficiencies in their knowledge of the phonics program. Specifically, teacher knowledge is lacking in these areas: a) vowel sounds and principles; b) consonant blends and digraphs; c) vowel irregularities; d) consonant irregularities; and e) strategies for teaching phonics.
3. Teachers do not immediately learn the content of phonics and the strategies for teaching phonic analysis while teaching.
4. Many methods courses in reading have not adequately prepared teachers to teach phonic analysis.
5. Teachers should know the total phonics program if they are to make wise decisions regarding what to teach, how much to teach, and for which learners phonic analysis instruction is most beneficial.

6. Teachers readily admit their limitations in phonics and recognize phonics as an integral part of the reading program; they are willing to learn the content and instructional strategies and principles that will enable them to do better jobs in the classroom.

Computer-assisted instruction. The survey of the literature on computer-assisted instruction led to these conclusions:

1. A quality program in computer-assisted instruction is the product of a creative and informed course author and instructional programmer.

2. CAI offers possibilities for efficiently individualizing instruction that are unparalled by other existing instructional systems.

3. The most effective mode of CAI for teaching teachers phonics content and instructional strategies is the tutorial mode in which the computer imparts the information, guides the learning and does the evaluation of the learner's performance.

4. A well-developed computer-assisted instruction tutorial program follows a set of developmental procedures which include: a) specifying terminal criterion objectives; b) developing criterion test items; c) authoring course materials and translating these materials to the CAI medium; d) editing and revising course materials; e) pilot testing and revising; f) retesting and revising; g) validation; and h) documentation.

5. The following data are important in documenting course validation: a) number of persons tested; b) description of the

target population; c) the minimum acceptable standard set for validation; d) the percentage of attainment; e) the method used to validate the hierarchy; f) the results of the evaluation; g) the mean time for the module and h) a replicable version of the course content and strategies.

6. In order to validate a computer-assisted instruction course, the researcher must establish a criterion level which must be attained before the course can be deemed a valid and reliable course.

7. The minimum criterion level for validation is 80/80.

8. Between five and ten students should be used in the testing and revising process.

9. A minimum of 15 students should comprise the validation group.

10. The effectiveness of a CAI course is subject only to its attaining of the preestablished criterion level for validation; comparison with other instruction is unnecessary and adds little to the research in CAI.

11. CAI research should focus on course optimization.

Criterion-referenced testing and CAI. These conclusions were generated by the literature on criterion-referenced measures:

1. Criterion-referenced measures are the most practical measures to use in determining student achievement in computer-assisted instruction programs.

2. Conventional indices of validity, reliability and item analysis are inappropriate with criterion-referenced measures.

3. The most reliable type of validity for criterion-referenced measures is content validity.

4. Content validity in general practice is determined by expert opinion of the course content, test items and objectives.

5. The criterion-referenced measure used in assessing learner achievement should be generally developed prior to instruction.

Procedures

The procedures followed in developing and testing the instructional materials for the computer-assisted phonic analysis course for preservice teachers are summarized in the following outline:

A. Formulation and Instructional Specification Phase
   1. selected a course topic for presentation via CAI
   2. defined the scope and sequence of instruction
   3. wrote terminal objectives
   4. developed criterion test items
   5. set validation criterion level

B. Product Development Phase
   1. authored instructional materials
   2. edited instructional materials for accuracy of content, consistency, grammar and syntax, and logical flow
   3. forwarded instructional materials to educational programmer for adaptation to the CAI system
   4. reviewed on-line materials
   5. revised by author and programmer as necessary

C. Product Testing and Revision Phase
   1. monitored the progress of four students through portions of the program

2. made first revisions as indicated by the data and comments from this first testing group
3. five additional students, typical of the population of preservice reading teachers, completed the on-line program; performance data and comments were collected for each subject
4. made second revisions as indicated by the data

D. Product Validation Phase

1. selected available students from preservice teacher population who volunteered to participate in the study
2. administered pretest via the computer terminal
3. presented appropriate CAI instructional materials to students as dictated by pretest performance data
4. collected and analyzed in-program performance data
5. administered posttest off-line and analyzed posttest performance data
6. determined if student performance met minimum acceptable standard set for validation
7. documented validated materials
8. performed and wrote operations analysis

The discussion of the outlined activities is in two parts: Part One covers parts A, B, and C of the outline and is an account of the planning, authoring, testing and revision phases; Part Two contains details related to the validation as outlined in part D.

Part One: Planning, Authoring, Testing and Revising

Planning. The first step in course development was to select a course topic for presentation. The topic, "Phonic Analysis: Content and Teaching Procedures," evolved from the existence of the problem as cited in Chapter I. The scope and sequence of instruction were determined based in part on research findings which identified the most useful phonic generalizations, in part from authoritative recommendations on what phonics content teachers need to know, and finally, on the basis of the writer's own judgment and the conventional wisdom found in professional texts. The resultant course outline is found in Appendix B. For purpose of CAI presentation the content was organized into seven segments. These segments were given the labels below:

Segments	
Phoni I	Readiness for Phonics
Phoni II	Consonant Blends
Phoni III	Consonant Digraphs
Phoni IV	Syllabication, Single Vowel Letter - Sound Relationships
Phoni V	Vowel Combinations: Digraphs and Diphthongs
Phoni VI	Consonant Irregularities
Phoni VII	Vowel Irregularities

The scope and sequence were then used as the framework within which the course objectives were written. In writing the objectives, the course author followed the practices and suggestions of other product developers and stated the objectives as specifically as was practical before course materials were written. The terminal objectives paralled the scope and sequence of the course content and indicated the learning criterion that should be met. Modifications in the scope and sequerce and the terminal objectives were made based on experience during the testing phases of program development.

Criterion test items were then developed for pre and post-course objectives. The in-course review items were written after the development of the instructional segments. These review items enabled the learner to evaluate himself during and at the end of each small instructional unit. Such evaluation served as a basis for further assistance or instruction as needed or desired.

After the pre and postcourse criterion items had been written, the criterion for validation was set at the 80/80 level. This level means that 80 percent of the learners would attain 80 percent of the terminal objectives. This criterion level was viewed as satisfactory since this was the initial validation trial of the program and because the level fell within the limits of the suggested criterion levels for validation found in the research literature.

Authoring. The second major step of course development was the authoring of the instructional materials. Before a unit of instruction was authored, several different presentation strategies and the available presentation modes were investigated.

Few instructional segments were "complete" after the first authoring. The materials were scrutinized for logical organization, feedback provisions, closure, opportunities for student participation, branching provisions, and provisions for individual learning rates. Revisions of the various instructional segments included changes in strategies, elimination of materials, and adding information. Following revisions, the authored materials were transferred to CRT author sheets, audio sheets or image planning forms.

Once a unit was edited and judged suitable by the author, it was then forwarded to the educational programmer who coded the paper rendition so that it could be accommodated by the appropriate CAI presentation medium--CRT, audio unit, image projector or a combination of these presentation media. These coded messages were then key punched on computer cards and loaded into the system. The cards were read by the computer and the authored materials were presented via the CAI terminal. Audio messages were recorded in tentative form to check their correspondence with the CRT text and the images were drawn up and placed in flip pads. These flip pads are simply three-ring notebooks containing a copy of each image. The images are numbered and correspond to numbers on a trial reel that is placed in the image projector. As the course is being tested, the number of the image that goes with a CRT or audio message is shown on the image projector; the student looks this number up in the flip pad and sees the copy of what is to later appear as the final image.

The information from the three presentation mediums--audio, image, CRT--was then coordinated to form a tentative but usable instructional segment. Each segment was developed in this manner.

Testing and revising. After several segments had been developed, they were presented to the first pilot or testing group. The progress of each student was carefully monitored by the author or another proctor. Each student was asked to comment on the materials specifically with regard to items they thought to be vague, superfluous, contradictory, difficult, irrelevant, poorly constructed, poor in format and appeal, boring, tedious or uninformative. All students responded to the segment frames on comment cards (see Appendix C) or on regular 3 x 5-inch index cards. The students' comments were then organized according to the frame labels and revisions were made as the data dictated. Revisions ranging from the correction of spelling errors to the rewriting of complete units were made. Samples of comments from the first testing group are in Appendix C.

After the first major revisions were made, the five students comprising the second testing group went through the course. These students were directed to evaluate the course in much the same way as the first testing group. Unlike the first group however, these students received minimum monitoring. They were attended only when they requested assistance. The performance data of these students were collected and the second revisions were made accordingly. The revised course, including final audio messages and image reels, was then made ready for the validation group.

Prevalidation results. The students participating in the preliminary testing provided valuable comments and suggestions for course revision. Students in the first testing group were more "critics" than learners--although performance data were collected and reviewed. These students were directed to question anything that appeared in need of revision. Their suggestions and performance were the crux of the major revisions. The following are illustrative of the changes which resulted from the first testing group's suggestions and performance:

Introductory frames stating the purpose of the pretest were written.

Several vague pretest items were rewritten.

Loops were shortened for getting to the correct answer on several supportive but non-criterion related items.

A tedious activity was removed from Phoni I.

The exercises dealing with the illustrative lessons in Phoni I were completely rewritten.

The performance tasks in Phoni II were changed from recognition tasks to reproduction tasks so that practice would be more in line with expected terminal behavior.

Feedback for unanticipated responses was updated and coded.

More provisions were made for optional review.

Several superfluous frames were deleted.

Reminders to take notes were inserted at each opening frame.

Because of the major course revisions and the many interruptions in course flow that transpired, the performance data from the first testing group were not considered for predictive purposes, but were used solely for revisions.

The second group of students was on-line predominantly as "learners," though they were advised to make criticisms and to comment as necessary. Performance data were collected and analyzed as predictive of the performance of the validation group. Comments and records from the second group were also used for revisions though the major revisions had been made from the first testing group, the author's reviews and the reviews of several interested parties.

The students involved in both preliminary tryouts indicated that the course materials taught them phonics. The students especially favored the objectives presented at the beginning of the instructional segments and the summary of their pretest performance. The chance to construct generalizations was another popular feature of the course. Other features that drew favorable responses included the strategy of "cueing the learner" to the correct response [inductive] rather than telling him, the prompt feedback, the self-evaluation opportunities and the illustrative lessons.

Several of the instructional strategies employed in the Phonics Course are described in Appendix D. The preliminary testing with the second testing group indicated that the course did teach phonic analysis and instructional procedures and principles. Each of the five students in the second testing group met criterion.

Part Two: The Validation Plan

The validation design. The research design employed in this study has been described (Sparks, 1967) as the "One Group Pretest-Posttest Design." The design is seen in Figure 2 on the following page. The procedures in employing the design were to give the pretest which measured the state of the group with respect to the criterion tasks, administer the CAI Phonics Program and give the posttest which measured the standing of the group on the criterion tasks after treatment. The following characteristics and advantages (Sparks, 1967, p. 19) were features which rendered the design suitable for this study.

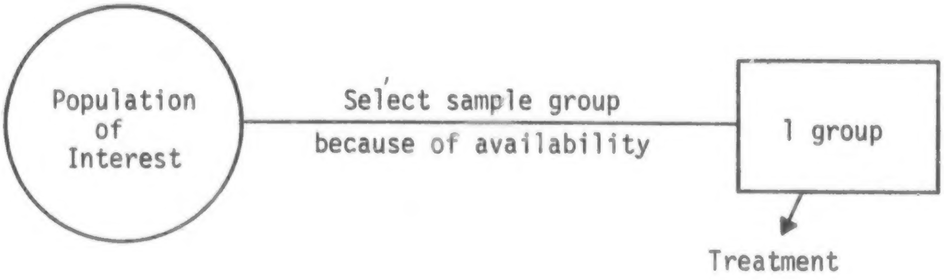

Fig. 2. One group pretest-posttest design.

1. The selected group is analyzed by the individual student units of which it is composed.
2. Only one group is studied and measured.
3. Pre and post measures allow comparisons of the status of the group after treatment with its status before treatment.

Treatment. The validation group, consisting of 36 preservice teachers, took the CAI Phonics Course. Upon signing on to the course, students were taught how to use the CAI terminal, administered the pretest and branched to the appropriate instructional segments as determined by their pretest performance. Each student was given a summary of his pretest performance and an overview of instruction at the beginning of each instructional segment to which he was branched. After instruction was completed, students were so informed and then directed to the posttest which was administered off-line.

The complete flowcharts for the pretests and for instructional segments are in Appendix E. The pretest flowcharts provide a graphic representation of the branching and decision processes based on pretest performance. The flowcharts indicate to the reader the specific questions to which the student may be sent in the pretest, depending on the student's prior performance, and the performance criterion for the question. The flowcharts provide a blueprint from which a researcher or teacher who wishes to implement the program might build upon. For the educational programmer, the flowcharts provide a graphic representation of the use of switches and counters.

The instructional flowcharts provide the same information about instruction as the pretest flowcharts provide about the pretests. All computer-controlled instruction and student options are charted. The reader is provided a concise scope and sequence of the total instructional program as well as a look at the several discrete instructional programs available to students. The computer-controlled instruction, based on the student's pretest performance, is indicated in the rectangular boxes that branch from the diamond-shaped decision boxes.

Course Analysis and Validation Data

Numerous data are available from a group's performance in a CAI course. The data to be collected, however, are necessarily delimited by the research question and the purposes of the research. The major question posed in the research was: Is this program effective to the extent that 80 percent of the learners attain 80 percent of the terminal criterion objectives? The purpose of the research was to develop, test, revise, retest and validate the Phonics Program for preservice teachers.

Data source. All data, with the exception of the posttest performance and the operations analysis data, were obtained directly from the individual student records that are stored on a course master tape. Individual student performance was recorded per session. These performance records include the following information:

- Time of day
- Course name
- Date
- Response identifier
- Actual response
- Cumulative time on-line
- Switches
- Student number
- Segment
- Enter Process (EP) identifier
- Response latency
- Number of responses to EP
- Counters

Specific data from the performance records were retrieved from the course master tape by using specially designed library programs. Some of the library programs were used to provide daily performance data; other programs were used for sorting data at the end of the course.

Precourse performance data. In order to determine what instruction was needed by the students, precourse performance data were collected and organized for individuals and for the group. In addition to prescribing instruction, the pretest performance data also provided a basis for drawing conclusions about pre-instructional pre-service teachers' phonics knowledge in general. The following data were sorted according to the specific pretest questions:

Pretest number
EP identifier
Number of students presented question
Specific question
Concept area
Number of students branched over an instructional segment

These data relating to the specific pretest questions were organized and reported on Form A seen in Figure 4 in Appendix F.

Pretest performance data were also sorted and reported according to the individual student. The data below were sorted from the master tape and reported on Form B shown in Figure 5 in Appendix F.

Student ID number
Number correct responses
Weighted score in percent
Number questions presented
Percent correct responses
Total pretest time

Pretest summary data are reported on Form C shown in Figure 6 in Appendix F. The summary data were analyzed without a library program and include these items: mean number of pretest questions correct, mean weighted score in percents, standard deviation of pretest scores, and range of pretest scores.

Incourse item analysis data. In order to determine the effectiveness of particular items to which students responded during incourse instruction, the following summary data on each major EP identifier were requested from the master tape:

Segment
Number of students presented EP
Number incorrectly responding on last try
Mean number of responses to the EP
EP identifier
Number correctly responding on first try
Difficulty level of the EP (ratio and percent of the number of students who got the item correct to the number of students who tried the item)

Number of students for whom the response latency was greater than one minute

Response mode

Form D, on which the incourse item analysis data are recorded, is shown in Figure 7 in Appendix F.

The actual responses to each EP were also requested in order to examine the nature of responses that had not been anticipated and were correct in order to update the correct answer sets.

Materials validation data. These data were collected to determine if the course met the 80/80 criterion level set for validation:

Percent correct responses on posttest from top 80 percent of the group;

Percent of objectives obtained per percent of total validation group (i.e., 20 percent of the students attained 100 percent of the objectives; 40 percent of the students attained 80 percent of the objectives).

The form for reporting the materials validation (posttest) data is seen in Figure 8 in Appendix F. In addition to answering the research question, the posttest data were helpful in assessing the efficiency of the materials related to each terminal criterion test item and the item itself.

The percent of students getting each posttest question correct was recorded on Form F in Figure 9 of Appendix F. While there is no specific level for determining such efficiency, the criterion established by the researcher was 80 percent. That is to say, each terminal criterion item will be answered correctly by at least 80 percent of the group. If the item is not answered correctly by the designated percent, the instructional materials related to the item and the item itself will be reevaluated. Summary data for pre and postcourse performance and for student on-line time were placed on a summary chart to show individual student pre and posttest differences. These data were recorded on Form G seen in Figure 10 of Appendix F.

The operations analysis. The operations analysis was carried out to enable the researcher to look critically at the completed project regardless of the outcome of the validation study. This close scrutiny was undertaken to note objectively the strengths and weaknesses inherent in developing and operating the course. The operations analysis was not performed according to any prescribed rules; however, the principles cited below (Popham and Baker, 1971) were observed:

1. Operations analysis should be performed at the conclusion of all systematic development of instructional products. [p. 158]
2. The operations analysis should be written and transmitted to some central repository. [p. 158]

Operations analysis data were gathered from the responses to questionnaires filled out by each individual instrumental in the development and/or operation phases of the program. The individuals included the educational programmer, the graphics artist, the systems analyst, the audio specialist and the technical support manager. The questions below made up the questionnaire:

1. What specific operations did you perform in the development of the Phoni Course?

2. Did you experience any complications or difficulties in performing these operations for the Phoni Course? If so, could you specify the task and the difficulty?
3. Would you make specific recommendations for improving the future performance of these tasks, or possible ways of avoiding these complications?
4. Do you have any general recommendations for the future optimization of this product?
5. Did you note any practices incorporated in the operation of this program that you believe should be maintained or that you consider assets?

When all questionnaires had been returned, the responses were analyzed for the operation's strengths and weaknesses as perceived by working personnel.

Analysis of data. Following the collection and organizing of data, the primary analysis was performed to determine whether the validation criterion had been achieved. The data from the items analysis forms were then analyzed to determine if any criterion objectives were below the 80 percent criterion level, and which items and materials warranted reevaluation and possible revisions.

The secondary analysis looked at the data on these forms: 1) precourse data forms; 2) incourse data forms; and 3) operations analysis forms.

Criterion Tests:
Development, Scoring, Analysis

Pretest development. The pretest was developed to assess the learner's knowledge of phonic analysis, and to serve as the basis for branching into the instructional program. Because of the many branches that could logically result from test performance, administering the pretest via the computer terminal was faster and more accurate than off-line administration. The pretest was developed from the specification of the behavioral objectives and on a concept-level contingency hierarchy. The concept-level contingency hierarchy is illustrated in these three questions that deal with the short vowel sound:

a) What is the same about the vowel sounds in these words?

[cupdap] [dollup] [fedmip] [ilslep]

If the student did not assign the label "short vowel sounds" he was branched to the first question dealing with the next concept on the pretest. If the learner supplied the correct label, he went on to the question that follows:

b) Put your earphones on to listen to some words containing vowel sounds. The words will be given in pairs. Type one of the words from the pair which could serve as a key word for the short sound of each vowel. Type the word under the vowel letter whose short sound is heard.

a	e	i	o	u
______	______	______	______	______

If the learner identified the vowel sounds correctly, but could not recognize short vowel sounds in words, it was inferred that he had problems with auditory discrimination or that he "guessed" the label and would therefore not know the rule(s) governing the concept. If the learner did not identify each word in which the vowel sound was short, he was branched to the first question dealing with the next concept in the next pretest section. If he answered correctly, he was presented this task dealing with the short vowel sound generalization:

c) Complete these phrases to construct the generalization for the vowel sounds in cat and imp: In a word or syllable in which there is ______ which ______ the word or syllable, the vowel sound is short.

If the learner answered all three questions correctly, the program branched him over instruction dealing with short vowel sounds. He was, however, given an opportunity to review that portion of information once his instruction began. He was also sent into the illustrative lessons dealing with short vowel sounds.

The more questions a learner correctly answered in his pretest, the less instruction he received; the fewer pretest questions answered correctly, the more instruction received. The contingency hierarchy saved time for the student who did not demonstrate the necessary knowledge to branch over instruction in a respective area by not presenting him with items above the difficulty level of any preceding one which the student could not answer. The hierarchy in the pretest enabled the student who possessed the knowledges to demonstrate them and be exempt from superfluous instruction or practice.

The pretest items may be classified as the selection or completion type (Remmers, 1965) in that the learners selected their answers from among given alternatives or filled in blanks to complete statements. Since a review of the literature revealed that reliability data made little or no contribution to criterion-referenced tests, the content validity of the test items was determined by judging the compatibility of the test items with the behavioral objectives.

Posttest development. The posttest questions were, for the most part, the supply type (Remmers, 1965); the learner supplied all components of the answer to essay type or short answer questions. This type response was evaluated off-line rather than by the computer system because the system is limited in its ability to evaluate and process constructed, whole-line responses which may be stated correctly in numerous ways. Too, it was felt that the learners would have more freedom in the way they answered if answers were evaluated off-line. The posttest questions were more comprehensive in that one posttest question may have been designed to elicit five features in one answer, whereas the pretest question usually elicited only one. The pre and posttest questions dealing with readiness for phonic analysis are illustrative of the differences in pre and posttest questions.

On the pretest, these five items were used to determine if a learner knew the labels and the explanations of the prerequisites for phonics that were taught in this course:

1. Directions: Before a child can profit from instruction in phonic analysis, he must have acquired certain skills and knowledges and developed certain abilities. Look at the list of skills, abilities, and knowledges shown on the image. Type the number of each statement that is one of four prerequisites for phonic analysis: __, __, __, __.

   [students see list on image screen and selects and types in the numbers next to the answers of their choice]

   [students press light pen to the answer of their choice for the questions below]

2. To what does auditory discrimination for phonics instruction refer?

   [ability to distinguish whole words in oral form]

   [ability to distinguish sounds in a word]

   [ability to hear all sounds in the spoken language]

3. To what does visual discrimination for phonics instruction refer?

   [ability to see similarities and differences in printed letters]

   [ability to recognize printed letters]

   [ability to perceive the whole word as a unit]

4. Why does a child need to know the letters of the alphabet by name and shape for phonics instruction?

   [to help in identifying correct sounds]

   [to see that each letter stands for a particular sound]

   [to facilitate communication in the teaching-learning process]

5. Why is the child's ability to recognize some whole words in printed form important for phonics instruction?

   [to provide reference points for introducing letter-sound relationships]

   [to help the child understand the concept of a word]

   [to facilitate pupil-teacher communication]

On the posttest, this one question measured the same knowledges as the five pretest questions above:

> Name the four prerequisites for phonic analysis and discuss each as it relates to the teaching and learning of phonic analysis.

Every learner was presented every posttest question. The pre and posttest and the weighting scheme explained below are in Appendix G.

Weighting and scoring test items. Pretest items were usually weighted one (1) point each because only one feature was present in each test item. If a series of items comprised the answer, then a student had to attain at least 75 percent of the items to receive the full point value of the item. Fewer than 75 percent rendered the item worth no points.

The "Check-List Point-Score Method" was employed in weighting and scoring the short answer and essay questions on the posttest. This scoring method (Remmers, 1965) required breaking up the ideal response to the question into a series of features or points. The learner's answer was then evaluated with respect to each feature and a point was awarded if the feature was present in the response. The features tested for in the posttest responses were the same features tested for in the pretest. The pre and posttest weighting schemes are given on the pre and posttests. The features for which points were given in the posttest are underlined with the points in parentheses.

Arriving at percent for validation criterion. In order to validate the course, the criterion of 80/80 had to be met. Eighty percent of the learners had to attain a minimum score of 74 of the possible 92 points for the course to meet the criterion level for validation. The percent value per points was calculated so that a certain number of points would be equal to 80 percent (i.e., 9 points = 10 percent; 19 points = 20 percent; 47 points = 50 percent).

Course documentation. Documentation of the CAI course includes the compilation of information about the developed and validated course materials available from the DOCUMENT Program (Watts, 1970) developed at The Pennsylvania State University.

The printed documentation provides two sets of information: one set is a concise and accurate description of the course; the other is within the technical arena and deals with programming language and system functions. The course description consists of all possible CRT displays available to students and a description of answer processing. Each frame carries its label, indication of pauses, character descriptors (e.g., apostrophes mean character is alternate coded), the row and column in which the text begins. Below the screen display, the response mode and time allotment for an answer are indicated. DOCUMENT then describes the treatment for each possible answer. Treatment may include branching, passing to the next frame, returning to past instruction. Use of other interface devices--audio or image--is shown by special messages. The description is a sequential and graphical representation of a course.

The set of technical information provided by DOCUMENT includes the actual Coursewriter statements (the programming language) used in the course. In addition, the heading on each page notes the course name and segment, date and time of day of the DOCUMENT run and the pagination. The cross-reference table shows which audio, buffers, counters, functions, film, images, labels, macros, return registers, switches, and counters used as switches have been used and where.

The DOCUMENT System, programmed in PL/1 for an IBM 360/67 System, is compatible with any 360 system containing a standard PL/1 compiler. Other documentation data for the Phoni Course include a description of instructional strategies, flowcharts of each instructional segment, the EP identifier scheme, the match identifier scheme and the macro and dictionary use. Complete course documentation is in the central repository in the Computer Assisted Instruction Laboratory at The Pennsylvania State University.

CHAPTER IV

ANALYSIS OF DATA AND RESULTS OF FINDINGS

The findings from the collection of four types of data are reported in this chapter: 1) findings related to pretest performance; 2) findings related to in-course materials analysis; 3) findings related to posttest performance and criterion test items analysis, and 4) findings from the operations analysis. The findings are reported under the headings and in the order enumerated above and are prefaced with the purpose for which those data were collected.

All performance data, with the exception of posttest data, originated from the individual student records that are stored on the course master tape. The data were sorted, collated and printed from the course master tape by using special library programs designed to analyze data at The Pennsylvania State University Computer Assisted Instruction Laboratory. Additional data were generated from the printed listings.

Findings Related to Pretest Performance Data

The main objective in gathering pretest performance data was to appropriately branch a student to instruction based on his prior knowledge of the concept to be taught. Such branching was in line with the premises on which computer-assisted instruction was built--that of individualizing instruction. In addition to providing a basis for branching, the data from pretest performance were used to report the general status of preservice teachers' phonics knowledge without instruction. These data were assembled from the course master tape and presented the following information: 1) total number and percent of students presented and correctly answering each pretest question (meeting criterion); 2) total number of students branched over each instructional segment; and 3) total number of students branched over all instruction.

Individual student pretest performance scores were listed in order to provide the full range of pretest scores. The number of minutes spent in the pretest was collected for each student in order to determine the ratio of time spent in the pretest to that spent in instruction.

Findings: number and percent of students presented and correctly responding to pretest questions. Table 1 contains the performance data for each pretest question. It was found that 17 or 47 percent of the students met criterion on the first question in Pretest 1. Of the 17 students who correctly selected at least three of the readiness factors, 10 chose the appropriate answers which related at least three of the readiness factors to phonics instruction. No student achieved a perfect score on the pretest dealing with readiness for phonics. Nineteen, or 53 percent of the students did not meet criterion on the first pretest question and were therefore not presented the four related questions for that pretest.

Pretest 2 measured the preservice teachers' knowledge of consonant blends. Thirty-four or 94 percent of the students recognized the examples of consonant blends (question 1); two or six percent did

Table 1

Pretest Performance by Question

Pretest	EP Identifier	Concept Area	Number of Students Presented Question	Percent	Number of Correct Responses to EP (Criterion)	Percent	Number Branched Over Instruc.
1	AAP01	Phonics Readiness	36	100	17	44	
	AAP02	Auditory Discrim.	17	47	11	31	
	AAP03	Visual Discrim.	17	47	14	39	
	AAP04	Alphabet	17	47	2	6	
	AAP05	Whole Words	17	47	14	39	0
2	CAP01	Recog. Blends	36	100	34	94	
	CAP02	Definition Blends	34	94	7	19	
	CAP03	Naming Blends	7	20	2	6	2
3	CFP01	Recog. Example	36	100	35	97	
	CFP02	Label Example	35	97	3	8	
	CFP03	Definition Digraph	3	8	3	8	
	CFP04	Naming "H" Digraphs	3	8	0	0	

Table 1 (Continued)

Pretest	EP Identifier	Concept Area	Number of Students Presented Question	Percent	Number of Correct Responses to EP (Criterion)	Percent	Number Branched Over Instruc.
3 Cont.	CFP05	NG	3	8	0	0	
	CFP06	CK	3	8	1	3	
	CFP07	Digraphs	0	0	0	0	0
4	VCP01	Short Vowel Sound in Words	36	100	31	86	
	VCP03	Key Words	31	86	8	22	
	VCP04	Generalization	8	22	3	8	3
5	VEP01	Syllab.	36	100	24	67	
	VEP03	Dividing Words	24	67	20	55	
	VEP05	Principle: Between 2 Con.	20	55	0	0	
	VEP06	Principle: After First Vowel	20	55	0	0	0
6	VGP01	Y and W	36	100	13	36	
	VGP02	Y Words	18	50	15	42	
	VGP03	Principle	15	41	8	22	
	VGP04	Principle	8	22	1	3	

Table 1 (Continued)

Pretest	EP Identifier	Concept Area	Number of Students Presented Question	Percent	Number of Correct Responses to EP (Criterion)	Percent	Number Branched Over Instruc.
6 Cont.	VGP05	Vowel Sound	1	3	0	0	
	VGP06	Vowel Sound	0	0	0	0	
	VGP07	Vowel Sound	0	0	0	0	
	VGP08	W	6	17	4	11	
	VGP09	W	4	11	0	0	0
7	VAP01	Long Vowel Sound	36	100	30	83	
	VAP02	Long Vowel Sound	30	83	20	55	
	VAP03	Gen: Final E	20	55	0	0	
	VAP04	Gen: Single Final	20	55	0	0	
	VAP05	Gen: Adjacent	20	55	0	0	
	VAP06	Modification	0	0	0	0	0
8	WAP01	Diphthongs	36	100	24	67	
	WAP02	Definition	24	67	14	39	
	WAP03	Digraphs	36	100	4	11	

Table 1 (Continued)

Pretest	EP Identifier	Concept Area	Number of Students Presented Question	Percent	Number of Correct Responses to EP (Criterion)	Percent	Number Branched Over Instruc.
8 Cont.	WAP04	Definition	4	11	2	6	
	WAP05	Digraphs - Diphthongs	2	6	2	6	2
9	ECP01	"Silent" Letters	36	100	34	94	
	ECP02	H	34	94	19	53	19
	ECP03	W	34	94	10	28	10
	ECP04	GH	34	94	19	53	19
	ECP05	K	34	94	15	42	15
	ECP06	L	34	94	34	94	34
	ECP07	P	34	94	5	14	5
	ECP08	G	34	94	11	31	11
	ECP09	B	34	94	28	78	28
	ECP10	Soft C & G	36	100	33	92	
	ECP11	Soft C & G	33	92	31	86	
	ECP12	Soft C & G	31	86	8	22	
	ECP13	Soft C & G	8	22	6	17	
	ECP14	QU	36	100	30	83	
	ECP15	QU	30	83	23	64	23
	ECP16	S	36	100	28	78	
	ECP17	S	28	78	25	69	

Table 1 (Continued)

Pretest	EP Identifier	Concept Area	Number of Students Presented Question	Percent	Number of Correct Responses to EP (Criterion)	Percent	Number Branched Over Instruc.
10a	VJP02	SCHWA	36	100	9	25	
	VJP03	Definition	9	25	4	11	
	VJP04	SCHWA	4	11	4	11	
	VJP05	SCHWA	4	11	1	3	
	VJP06	SCHWA	1	3	1	3	1
10b	VPP01	R Controlled	36	100	10	28	
	VPP02	R Controlled	10	28	7	19	
	VPP03	R Controlled	10	28	3	8	3
10c	VMP01	AL,AW,AU,ALL	36	100	6	17	
	VMP02	AL,AW,AU,ALL	6	17	5	14	5
10d	VSP01	Sounds of OO	36	100	4	11	4
10e	VVP01	O - LD	36	100	16	44	
	VVP02	Gen.	16	44	0	0	0
	VVP03	IGH,ILD,IND	36	100	29	81	
	VVP04	Gen.	29	80	0	0	0

not. Of the 34 students who correctly chose the term consonant blend as the label, only seven chose the appropriate descriptor of a consonant blend (question 2). The criterion for naming blends (question 3) was 17/20. Of the seven students who chose the appropriate descriptor, two met criterion on question three of the second pretest.

Pretest 3 measured the preservice teachers' knowledge of consonant digraphs. Thirty-five or 97 percent of the students recognized the example ph in the word phonograph as a consonant combination. Of this 35, three were able to identify the combination as a consonant digraph (question 2). Question three asked the students to select the best descriptor of the consonant digraph; all three of the remaining students responded correctly. These same three students were then presented question 4 which required that they name the six h digraphs, question five, the ck digraph, and question six, the ng digraph. The composite criterion for naming digraphs was 8/8. Neither of the students met the criterion; therefore, no student received questions seven through ten which required naming the single letters which represent the digraph sounds.

Pretest 4 consisted of three questions about short vowel sounds in words. The first question required that the students select the label for the vowel sound in selected words. Thirty-one or 86 percent of the preservice teachers responded correctly. The second task (question 2) was that of selecting, from spoken pairs of words, the word in which the vowel sound was short. Eight students met criterion (5/5) on the task. The third task (question 3) required that the student complete a statement which composed the generalization for short vowel sounds in words. Three of the eight students composed the generalization satisfactorily.

Pretest 5 tested preservice teachers' knowledge of syllabication. Twenty-four or 67 percent of the learners identified the process (question 1). Of the 24 learners who identified the process, 20 met the criterion of syllabicating five, two-syllable words. The next tasks, (questions 3 and 4) required that the students complete statements of syllabic principles that governed the syllabication of the words. Neither of the 20 students met criterion on the last two tasks.

Thirteen of the learners met full criterion (y and w) on the first task in Pretest 6. Fifteen of the 18 students who named y as sometimes representing a vowel sound were able to identify, from among eight words, the six words in which y stood for a vowel sound (question 2); eight stated one of the instances in which y represented a vowel sound; one student stated the two instances. None of the students were able to identify each of the resultant vowel sounds recorded by y (questions 5, 6, and 7). Five of the students naming y also identified w as a consonant letter which could represent a vowel sound; one student named only w. Neither of the six students identifying w could cite the instance when w represented a vowel sound in words.

The performance data from Pretest 7 revealed that 30 or 83 percent of the students were familiar with the term "long vowel sound" and chose this as the label for the vowel sounds in the words presented. Twenty of this 30 met criterion on the second task (question 2) by identifying from five groups of four words, the words in which the vowel sound was long, and giving the name of the vowel letter whose long sound was heard. Criterion for this task was 5/5. None of the 20 who identified the long vowel sounds in the words was able to complete the statements of generalizations (questions 3, 4, and 5) for the vowel sounds in sets of words presented on the image. The final question was not presented to any of the students since it was contingent on the students having met criterion on question 5.

Pretest 8 tested the preservice teachers' knowledge of vowel letter combinations. Twenty-four or 67 percent correctly chose the label diphthong (question 1) for the underlined combinations in the words presented. Only 14 of the students who assigned the appropriate label selected the correct descriptor (question 2) of the diphthong. Question three presented words in which the underlined vowel combinations were digraphs. Four or 11 percent of the preservice teachers chose the correct label; two of these four selected the statement that most accurately described a vowel digraph (question 4). The two students who responded correctly to the first four questions both met criterion on the remaining task (question 5) of identifying combinations as diphthongs or digraphs.

Pretest 9 measured the preservice teachers' knowledge of consonant irregularities. Thirty-four or 94 percent of the students correctly noted the examples of letters not representing sounds in certain combinations as "silent letters" (question 1). Only these 34 learners were presented the questions dealing with eight specific instances of "silent letters." The findings follow: 19 students responded correctly to h as a silent letter (question 2); ten students knew when w did not represent a sound in words; 19 students selected at least two of the three instances in which the combination gh did not record a sound in words (question 4); fifteen named g and k as not representing sounds when followed by n in the same syllable (question 5); thirty-four students responded correctly to "silent l" (question 6); five students answered the question dealing with "silent p" (question 7) and 11 cited the rule for "g before m" (question 8); and 28 responded correctly to question 9 which dealt with "silent" b.

Questions 10 through 13 dealt with the soft c and g rule. Thirty-three or 92 percent of the students selected j as the letter representing the soft g sound; thirty-one identified s as the letter representing the soft c sound. Only those learners correctly answering questions 10 and 11 received question 12 which required the selection of the three letters which determine the soft sound of c and g. Eight students identified the three letters, e, i, and y; six students noted the position of these letters (question 13) when they control the sound of c and g. Thirty students correctly selected u as the companion to q (question 14); and 23 chose the combination (question 15) which represented the qu sound. The last two questions dealt with the sounds represented by s. Twenty-eight students chose the word in which s represented its most common sound; twenty-five named z as the letter representing the sound of s in his and runs.

The last pretest, Pretest 10, measured knowledge of vowel irregularities and is in five parts. The five questions in part a deal with the "schwa" sound. Nine students correctly selected the term schwa as the label for the vowel sound in the unstressed syllables in spoken words; of the nine who selected the correct label, four selected the best descriptor (question 2) of the schwa and the situation in which the schwa occurs (question 3). One student correctly responded to the remaining two questions (4 and 5). Part b of the pretest measured knowledge about the effect of r on vowel sounds. Ten students selected r as the "vowel controller" (question 1); seven selected the appropriate descriptor of an r-controlled vowel sound (question 2). Three students noted the position of r when it controlled the vowel sound.

Part c of Pretest 10 contained two questions about the effect of l, w, u, and ll on the sound represented by the letter a. Five students chose the spelling representing the resultant vowel sound. Part d of the pretest contained one question about the sounds represented by the combination oo. Four students met criterion on this question. The last section, 10 e, contained four questions about the effect of ld on o and the effect of ld, gh, and nd on i. Sixteen students pointed out the word in which the vowel sound was an exception to the generalization for short vowel sounds (question 1); none stated the generalization covering the exception, (question 2). Twenty-nine students correctly responded to the third question by selecting the word in which the vowel sound conformed to generalizations for vowel sounds from a set of exceptions. Neither of the 29 students stated the generalization covering the vowel sound in the remaining words.

Pretest performance by individual students. Pretest performance by individual student is reported in Table 2. The total pretest contained 116 questions. Twenty-six of the students were asked at least half of the pretest questions; five students were asked at least two-thirds (78) of the questions. The highest number of questions presented to any student was 91, with the lowest number being 36. It should be

Table 2

Pretest Performance by Individual Students

ID Number	Number Questions Presented	Number Correct Responses	Total Points	Weighted Score in Percents	Total Pretest Time
PAM	44	22	7	7.6	48 min.
PBH0	50	25	13.5	14.6	54 min.
PBK	71	40	15	16.3	1 hr. & 18 min.
PBT	80	52	17	18.4	48 min.
PBW	59	37	16.5	17.9	1 hr. & 12 min.
PCA	73	55	18	19.5	1 hr. & 30 min.
PCK	68	37	9.5	10.3	42 min.
PCO	46	22	15.5	16.8	42 min.
PCO0	36	15	6	6.5	30 min.
PCS	57	40	17.5	19.2	1 hr.
PCV	75	51	16	17.4	54 min.
PDB	57	34	13.5	14.6	48 min.
PDC	64	37	10.5	11.4	48 min.
PDD	59	33	14.5	15.8	30 min.
PDF	61	36	12.5	13.5	1 hr. & 36 min.

Table 2 (Continued)

ID Number	Number Questions Presented	Number Correct Responses	Total Points	Weighted Score in Percents	Total Pretest Time
PDK	47	25	9.5	10.3	30 min.
PDK0	70	55	28.5	31	1 hr. & 12 min.
PGH	77	51	19.5	21.2	1 hr.
PJG	81	57	22.5	24.5	1 hr. & 12 min.
PJM	65	40	17.5	19	1 hr.
PKS	58	42	11	11.9	48 min.
PLJ	57	29	10	10.8	42 min.
PMB	91	60	23	25	54 min.
PMB0	72	51	11	11.9	48 min.
PMC	51	21	12	13	1 hr. & 18 min.
PMH	61	39	12.5	13.6	1 hr.
PMO	58	27	10	10.9	54 min.
PNM	62	30	14.5	15.8	36 min.
PNN	78	53	17.5	19	1 hr. & 12 min.
PPH	60	35	11	11.9	42 min.

Table 2 (Continued)

ID Number	Number Questions Presented	Number Correct Responses	Total Points	Weighted Score in Percents	Total Pretest Time
PPM	60	37	12.5	13.6	42 min.
PPR	39	16	6.5	7.1	16 min.
PPS	58	34	8	8.7	1 hr. & 6 min.
PPY	82	53	23.5	25.5	1 hr.
PSC	66	38	16.5	17.9	42 min.
PSN	64	46	16.5	17.9	54 min.

noted here that every student was presented the minimum number of pretest questions (i.e., the first in every hierarchy) which totaled 17. The number of correct responses per student ranged from a high of 60 to a low of 15. The number of correct responses, when converted to total points (points per feature) and weighted in terms of percent of total points possible, showed a high of 25.5 percent attainment with a low of 6.5 percent. As seen in Table 3 below, the mean percent of pretest attainment was 16.0; the standard deviation was 5.9 and the range was 19.0.

Table 3

Pretest Summary Data

Mean Correct Responses	Mean Weighted Score	Range of Scores	Standard Deviation (Weighted Score)
46.5	16.0	6.5-25.5 (19.0)	5.9

In terms of clock hours required to complete the pretest, the mean time was 54 minutes with a standard deviation of 18 minutes. The range of pretest completion time was from 30 minutes to one hour and 36 minutes.

Findings Related to Incourse Performance

Incourse performance data were collected in order to report findings from the operational use of the program in terms of instructional strategies, mastery of concepts during instruction and instructional time. These data were sorted and collated from the course master tape and are reported on Form C in Appendix H.

Segment containing EP

EP Identifier (enter and process is the point within the program that the computer "waits" for a response from the student)

Number of students presented EP

Number of students correctly responding on first try

Number of students responding incorrectly on last try

Difficulty level: Percent of students correctly responding to EP

Mean number of responses to an EP

Number of students whose response latency exceeded one minute for an EP

Response mode (light pen, keyboard)

The above data were reported only for the mastery items in the course. Every item represented by an EP identifier was not considered a major instructional item. The majority of the enter and process point tasks were concept builders and practice items. After the students had responded to the cueing and practice materials, the mastery task was presented to determine if and to what extent the student had conditioned to the cues and benefited from the practice. The means, standard deviations and ranges of instructional times are reported by segments and for the total course in Table 4.

The difficulty level of an item indicates the percent of students who attained mastery of the concept tested by the item. The difficulty level may also be reported as the inverse of those demonstrating mastery and be stated in terms of the percent of students for whom the item appeared too difficult for them to demonstrate mastery. If an item was difficult to the extent that _fewer_ than 80 percent of the learners-after instruction-demonstrated mastery, that item was designated for analysis, review and revision. The analysis would include reviewing the related cueing and practice materials, the instructional strategies incorporated, the response modes, and the mastery item itself in an effort to determine to what factors the difficulty might be attributed.

Segment I: phonics readiness, definition of phonics, suggestions for beginning instruction. In Segment I, 15 mastery tasks were achieved by at least 80 percent of the learners presented the task; a minimum of 80 percent of the learners did not demonstrate mastery on seven of the tasks. Of the seven tasks (noted by *) for which the recorded difficulty levels were below 80 percent, three were below 42 percent; three were between 72 and 74 percent, and one had a recorded difficulty level of 56.

The mean number of responses for 16 of the 22 items reported was one (1). Four items required a mean of two (2) responses and two tasks required a mean of three (3) responses. Response latencies

Table 4

Mean, Standard Deviation and Range of Instructional Time by Segment and Total Course

Instructional Segment	Mean Instructional Time	Standard Deviation	Range
Phoni I	1 hr. 48 min.	24 min.	1 to 3 hrs.
Phoni II	1 hr. 6 min.	12 min.	36 min. to 1 hr. 48 min.
Phoni III	1 hr.	12 min.	36 min. to 1 hr. 36 min.
Phoni IV	1 hr. 48 min.	20 min.	1 hr. 12 min. to 3 hrs.
Phoni V	1 hr.	12 min.	42 min. to 1 hr. 36 min.
Phoni VI	18 min.	12 min.	6 min. to 48 min.
Phoni VII	42 min.	12 min.	24 min. to 1 hr. 12 min.
All Segments (Including Pretest) Time	8 hrs. 42 min.	1 hr. 30 min.	6 hrs. 30 min. to 14 hrs.

greater than one minute were varied for the tasks but were found to be predominantly in the keyboard constructed or keyboard multi-lined response modes. A conspicuous trend relative to response mode, response latencies greater than one minute, difficulty level (or number of students demonstrating mastery) and number of correct first responses was detected. With the exception of EP aa46a 7, no question requiring a light pen response recorded latencies greater than one minute. All difficulty levels below 50 percent were from the tasks requiring multi-lined constructed responses, with one exception.

The mean number of hours required to complete Segment I was one (1) hour, 48 minutes. Student completion time ranged from one to three hours with a standard deviation of 24 minutes.

Segment II: consonant blends, instructional procedures and principles. It should be noted here that several responses were subjected to two evaluations. The first evaluations cited (ca37a a3, ca38a a3, ca39a a3, ca40a a3 and ca42a a3) were made by the author/ instructor. The corresponding evaluations (ca37a b7, ca38a b7, ca39a b7, ca40a b7 and ca42a b7) were student self-evaluations. The author/instructor evaluations were used for computing the difficulty levels that are discussed in the next chapter.

Some of the trends observed in the findings from Segment I were also evident in Segment II. The five mastery tasks not correctly responded to by at least 80 percent of the students were found to be in the multi-lined keyboard response mode. There were 25 tasks in all.

There were several light pen responses for which at least one student took longer than one minute to respond. It was determined that many of these light pen responses were related to multi-lined keyboard responses and to image "models" which students had to read before they could evaluate their responses and then enter that evaluation.

Each of the keyboard multi-lined responses had at least one student whose response latency exceeded one minute.

It was found with the first set of student-evaluated responses that the student and the author fully agreed on only one evaluation. One evaluation differed by three responses (29 versus 32); another by nine (21 versus 30) and another by 12 (11 versus 23). The mean difference was eight.

The mean time for completion of Segment II was one hour and six minutes. The range of student time was from 36 minutes to one hour, 48 minutes with a standard deviation of 12 minutes.

Segment III: consonant digraphs and procedural steps. Six or 27 percent of the 22 mastery task items did not conform to the desired difficulty level in Segment III. Of the six items, three had a difficulty level of 78; one was at 64. One item recorded a 44 percent difficulty level with the lowest difficulty level being 28. The mean number of responses to each item was one (1); and 12 tasks had at least one student with response latencies greater than one minute. An interesting fact was noted: eighteen of the students took more than one minute to respond in the light pen mode to the task identified by cf19a b7.

There were seven instances where students typed multi-lined responses and evaluated themselves. The author/instructor and student self-evaluations compared more favorably in this segment than in

Segment II. Complete agreement was found on the four evaluations identified by cf63a a3, cf63a b7; cf65a a3, cf65a b7; cf66a a3, cf66a b7; cf67a a3, cf67a b7. The differences on the remaining three evaluations were four (cf19a a3, cf19a b7), six (cf64a a3, cf64a b7) and two (cf68a a3, cf68a b7). The mean of the differences was four.

The mean instructional time for Phoni III was one(1) hour. The range of instructional time was from 36 minutes to one hour and 36 minutes, with a standard deviation of 12 minutes.

Segment IV: generalizations for vowel sounds and principles of syllabication. Segment IV contained 70 major tasks. At least 80 percent of the learners presented the task demonstrated mastery on 43 of the tasks. Five tasks had difficulty indices below 80 but above the 70 percent level; twenty tasks were at or above the 50 percent difficulty level. One task had a 42 percent difficulty level and one task had a difficulty level of zero. The mean number of responses to most of the items was one (1) with no item having a response mean greater than two (2).

Fourteen of the items having a difficulty index less than 80 percent were in the keyboard multi-lined, keyboard fill-in, or keyboard multiple choice response mode. Thirteen items were in the light pen response mode.

The largest number of students with response latencies greater than one was found for those tasks in which the light pen responses were related to self-evaluation (va19a b7, va27a b7, ve09a b7) or to multi-lined or constructed keyboard fill-in responses (vg17a 3, vg23a 3, vg27a a1, vg28a a1, ve13a k, ve17a blr). At least one student, but no more than two, had response latencies exceeding one minute on 25 additional tasks.

Student self-evaluations (va09a 7, va19a b7, va27a b7) were fairly consistent with author/instructor evaluations.

Segment IV required a mean instructional time of one (1) hour 40 minutes. Student time ranged from one hour and 12 minutes to three hours. The standard deviation of instructional time for Segment IV was 20 minutes.

Segment V: vowel combinations. There were 28 major tasks in Segment V. More than 90 percent of the learners demonstrated mastery on 23 of the 28 tasks. Two tasks were below the 80 percent difficulty level but above the 70 percent level; three recorded indices below the 50 percent difficulty level.

Three of the items not having satisfactory difficulty levels were of the keyboard fill-in response mode; the remaining three were in the light pen mode.

Most tasks recorded response means of one (1); four recorded means of two (2) and two tasks had a response mean of four (4). The number of response latencies greater than one minute was greatest for the keyboard fill-in type responses; one light pen response, however, recorded 11 students with response latencies greater than one minute.

This segment required a mean instructional time of one (1) hour. The range of instructional times was 42 minutes to one hour and 36 minutes. The standard deviation was 12 minutes.

Segment VI: consonant irregularities. Segment VI contained 22 mastery tasks--each of which recorded difficulty levels greater than 80 percent. More specifically, 20 of the items had difficulty levels of 100; two had difficulty levels of 88 and 89 respectively. The mean number of responses to all but three of the tasks was one (1) and response latencies greater than one minute were recorded for eight tasks. Item ec18a 1 recorded eight students with response latencies greater than one minute; seven items recorded either one or two students whose response latencies were greater than one minute.

The mean instructional time for this segment was 18 minutes. The standard deviation was 12 minutes with a range of 6 to 48 minutes.

Segment VII: vowel irregularities. Segment VII contained 25 mastery items. Twenty-one of these items recorded difficulty levels above 80 percent; four did not. The items recording the lowest difficulty level were of the keyboard fill-in response mode (vm06a b1) and the keyboard multi-lined response mode (vj08a 3).

The mean number of responses to all but one of the tasks was one (1); the exception (vj06a a1) required a mean number of two (2) responses.

Five of the items to which at least one student recorded response latencies greater than one minute were in the keyboard fill-in response mode; two were in the keyboard multi-lined response mode.

This segment recorded a mean instructional time of 42 minutes and a standard deviation of 12 minutes. Instructional time ranged from 24 minutes to one (1) hour and 12 minutes.

Findings Related to Posttest Performance

The findings from posttest performance data are reported in this section in order to answer the question of whether the course met the preestablished criterion level for validation (80/80). The findings were also used to determine which posttest criterion items did not meet the 80 percent criterion level. In addition, individual student pre and posttest performance was listed to show learning gains which could be attributed to the computer-assisted instruction Phonics Program.

Course validation findings. Performance of the validation group on the posttest is shown in Table 5. Inspection of the data in Table 5 revealed that 83 percent of the group attained between 80 and 89 percent of the terminal criterion objectives. All of the students attained a minimum of 30 percent of the objectives; but no student met 100 percent of the criterion objectives.

Criterion test items findings. The criterion test (posttest) consisted of 26 items. It had been indicated in the Validation Plan that each of the criterion test items should be met by a minimum of 80 percent of the students. If a test item did not meet the criterion level, that item would be starred (*) for reassessment. The findings, presented in Table 6, showed that 80 percent of the students met criterion on eight or 31 percent of the criterion test items. Since one question could measure the attainment of one or more of the objectives, an "objective-oriented analysis" revealed that the following objectives were fully met by at least 80 percent of the students:

Table 5

Materials Validation Data

Percent of Terminal Objectives	Percent of Validation Group Attaining Objectives
100	0
90-99	31
*80-89	*83
70-79	86
60-69	94
50-59	94
40-49	97
30-39	100
20-29	100
10-19	100

*80/80 Criterion Level

Table 6

Criterion Test Item Analysis Data

Posttest Question	Objective(s) Measured	Number of Students Meeting Criterion	Percent
1	1, 2	22	61
2	31	20	55
3	3, 4	23	64
4	5, 6	11	31
5	7	32	89
6	9	24	67
7	8	31	86
8	10, 11	5	14
9	12	33	92
10	13	18	50
11	14	24	67
12	15, 16	13	36
13	18	28	78
14	17	32	89
15	19	32	89
16	21	18	50
17	20	21	58
18	23	32	89
19	22	30	83
20	25	16	44
21	27	8	22
22	24	25	69
23	26	25	69
24	28, 29	28	78
25	32	24	67
26	30	26	72

Objective 1: The learner will name the four prerequisites for phonics instruction.

Objective 3: The learner will identify the distinguishing quality of a consonant blend.

Objective 5: The learner will describe the distinguishing quality of a consonant digraph.

Objective 7: The learner will write one key word for each short vowel sound.

Objective 8: The learner will correctly syllabicate two words and give the syllabication rule for each word.

Objective 12: The learner will write a one-syllable key word for the long sound of each vowel.

Objective 17: The learner will describe the distinguishing quality of a vowel diphthong.

Objective 19: The learner will name the four common diphthongs and write a key word illustrating the diphthong sound of each combination.

Objective 22: The learner will write one word in which _s_ stands for its most common sound.

Objective 23: The learner will name the vowel letter that accompanies _q_ in order for _q_ to be sounded in a word.

Individual posttest performance data. The posttest performance of individual students is reported in Table 7. This table also provides a recapitulation of individual student pretest performance.

The findings show gains by 100 percent of the learners. The minimum gain, in percents, was 23.5 percent (Student ID - PC00); the

Table 7

Summary Performance Data

Student ID Number	Percent Pretest	Percent Posttest	Cumulative Instructional Time On-Line
PAM	7.6	65	8 hrs. 45 min.
PBH0	14.6	88	9 hrs. 30 min.
PBK	16.3	72	9 hrs. 36 min.
PBT	18.4	83	7 hrs.
PBW	17.9	*79.8	7 hrs.
PCA	19.5	82	12 hrs. 30 min.
PCK	10.3	90	7 hrs. 6 min.
PCO	16.8	83	8 hrs. 30 min.
PCO0	6.5	30	8 hrs. 30 min.
PCS	19.2	65	7 hrs. 36 min.
PCV	17.4	84	9 hrs. 54 min.
PDB	14.6	86	7 hrs. 24 min.
PDC	11.4	83	6 hrs.
PDD	15.8	85	7 hrs. 12 min.
PDF	13.5	97	6 hrs. 48 min.
PDK	10.3	*79.8	7 hrs. 6 min.
PDK0	31.0	87	8 hrs. 48 min.
PGH	21.2	88	7 hrs. 48 min.
PJG	24.5	89	5 hrs. 54 min.
PJM	19.0	84	8 hrs. 24 min.
PKS	11.9	82	9 hrs. 18 min.
PLJ	10.8	90	7 hrs. 6 min.
PMB	25.0	92	7 hrs. 12 min.
PMB0	11.9	90	6 hrs. 48 min.
PMC	13.0	80	8 hrs. 54 min.
PMH	13.6	96	7 hrs. 48 min.

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*These scores were rounded to the nearest whole number in reporting them for course validation.

Table 7 (Continued)

Student ID Number	Percent Pretest	Percent Posttest	Cumulative Instructional Time On-Line
PMO	10.9	47	6 hrs. 18 min.
PNM	15.8	97	6 hrs. 18 min.
PNN	19.0	83	6 hrs. 24 min.
PPH	11.9	92	6 hrs. 54 min.
PPM	13.6	91	7 hrs. 36 min.
PPR	7.1	64	7 hrs. 36 min.
PPS	8.7	83	7 hrs. 36 min.
PPY	25.5	93	5 hrs. 30 min.
PSC	17.9	93	6 hrs. 54 min.
PSN	17.9	89	7 hrs. 54 min.

maximum gain was 82 percent (Student ID - PDF). The mean of on-line time was eight hours, 42 minutes with a range from six hours, 30 minutes to 14 hours. The standard deviation of on-line time was one (1) hour, 30 minutes.

Postcourse comments by students. After the course was completed and students had taken the posttest, general comments on the course were informally recorded. These comments were voluntary and were not limited to any prescribed question or to any particular areas.

The comments on the course are given in Appendix I by student number. All of the students who commented indicated that they felt they had learned phonics. Most of the students showed favorable attitudes toward computer-assisted instruction but expressed some frustration toward the malfunctionings of the system. Students appeared to like the ideas of self-pacing, self-competition, and self-evaluation. The repetition of concepts was viewed favorably by some students and as "overteaching" by others. The length of the posttest was viewed as excessive by several of the students.

Operations Analysis Findings

The operations analysis, while performed independently of the validation run, has direct implications for the validation study. Although well-designed and maximally coordinated operations do not necessarily result in a smooth-running, quality program, it is axiomatic that a smooth-running course is partly the result of well-coordinated and well-tested operations.

The operations included in the analysis are these technical functions: programming, image and CRT graphics production, audio recording and production, technical support management, and systems analysis and operations. The operations analysis data were secured by having course operations personnel fill out short, open-ended questionnaires. The completed questionnaires are in Appendix J. The findings are summarized below.

Programming. The programming operations for the Phonics Program appeared fundamentally satisfactory. However, two "malpractices" that occurred during the development of the course and that possibly resulted in errors during the operation of the course were cited by the programmer. These practices included: a) changes in audio script which were made at the time of recording without the programmer being notified, and b) some "last minute" author revisions before the validation run, which did not allow for adequate testing before use.

Technical support. The major difficulty encountered by the technical support manager was that of securing the image reels in time for testing with the course before the validation use. No reason was given for the difficulty, but it was implied that adequate notice had not been given to coordinate the production of the image reels.

Audio production. No complications were noted in the audio operations of the program.

Course development. Aside from the common difficulties experienced during the development and operations of a computer-assisted instruction program, the course developer and coordinator noted a complication which affected both the development, testing and operation of the Phonics Program. There were inadequate funds with which to direct the project. Because of this lack of funding, "cutbacks" were necessary in programming and other production areas.

During the operational run of the program, a major systems breakdown occurred which resulted in rescheduling and a decrease of terminal usage for the students.

In addition, during the operational run of the program, several problems arose that were due to minor programming "bugs." When the programmer or systems analyst was unavailable, countless minutes were wasted because the author/proctor did not have recourse to "moving" the student on through the course.

Image and CRT graphics production. The CAI artist, who developed and tested the CRT graphics and drew the final proofs from which the image reels were photographed, listed difficulties brought on by an initial lack of communication between the author and artist, and by last minute corrections. It was recommended that there be preplanning between author and artist and that a production schedule be established and closely followed. It was also recommended that the image reels be reshot in order to obtain sharper images.

Systems operations and analysis. The report from the systems analyst revealed that systems work related to the Phonics Program entailed no major adjustments. It was noted however, that the need for systems manipulation for operational debugging implied some programming errors which could have been avoided by additional testing. The one area in which the analyst acknowledged a need for change was in records processing. It was suggested that a time schedule for requests be set up and that only data which are to be used be requested.

Summary of Findings

The findings from the data analysis reported in each section are summarized and enumerated below:

1. Preservice teachers without phonics instruction are familiar with the headings under which specific phonic elements are classified (i.e., consonant blend, long vowel). They do not however, know the qualities of the phonic elements and the generalizations governing sounds in words. Students were especially unfamiliar with generalizations for vowel sounds, vowel irregularities and phonic readiness components.

2. The use of the contingency hierarchy and the branching in the pretest cancelled at least one-third of the pretest questions for learners who did not demonstrate knowledge of the concepts leading to the cancelled question.

3. On a percent-score basis for the total pretest, the mean percent attainment was 16 percent. Without instruction, the learners (as a group) demonstrated competency on 16 percent of the test items measuring the terminal objectives.

4. Of the 214 mastery items in the course, 160 or 75 percent recorded difficulty levels of 80 percent or higher. More specifically, 15 of the 22 incourse mastery tasks were at the desired difficulty level in Segment I. Twenty of the 25 mastery tasks presented in Segment II were at the 80 percent difficulty level. Sixteen of 22

incourse mastery items were at the desired difficulty level in Segment III. Segment IV recorded satisfactory difficulty levels for 61 percent of its 70 mastery tasks, while Segment V recorded learner mastery of 23 of the 28 tasks. Each of the mastery tasks in Segment VI had difficulty levels above 85 percent; and 84 percent of the 25 mastery items in Segment VII recorded difficulty levels above 80 percent.

5. Eighty-three percent of the group attained scores between 80 and 89 percent on the criterion posttest. The validation criterion level was 80/80.

6. Eight of the criterion test items met the 80 percent criterion level and the following objectives measured by the test items were fully met by at least 80 percent of the students: Objectives 1, 3, 5, 7, 8, 11, 17, 19, 22 and 23. Since the criterion test score was based on points assigned per feature, it should be noted that some students noted five of six features, or three of four features on some items. While such situations did not render the student as "fully" meeting the objective, it seems justifiable to point out that criterion on each of the test items was partially achieved by 80 percent of the students.

7. Every student showed gains from pre to posttest performance. The gains were empirically significant and ranged from 23.5 percent to 82 percent.

8. Voluntary student comments revealed a general satisfaction with the course. Complaints were registered for the posttest (too long, too vague at some points), for machine dysfunctions, and unnecessary repetition of some features.

9. Actual on-line time revealed wide dispersions between pretest time required, instructional time required for each segment and cumulative time on-line.

10. Most of the operations relative to the Phonics Program were deemed well-coordinated. Some difficulties were encountered because of last minute changes (programming, art work), insufficient preplanning and personnel coordination, and by the deadlines imposed in the records requests. The course was viewed by working personnel as an effective use of computer capabilities.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

Conclusions Based on Pretest Performance

The analysis of the findings from the pretest data led to the conclusions about the feasibility of pretests for branching students to instruction and about the status of the preservice teachers' phonics knowledge without individualized instruction. Recommendations for future use of the branching strategy and for upgrading preservice teacher knowledge based on the conclusions were listed.

Feasibility of branching based on pretest performance. The use of the "contingency hierarchy" appeared to have been a feature which saved both time and anxiety for learners who were only slightly or not at all familiar with the concepts; only five students were presented more than 75 percent of the questions. The theory that branching is economical was substantiated by the smaller number of instructional hours needed by students with the greatest number of correct pretest responses. The one student (ID Number - PCA) who did not fit the pattern was an ardent "note taker" who was observed spending an unusually large portion of her time copying information from the CRT or the image screen.

Confirmation of the feasibility of branching based on pretest performance was also found in posttest performance. Students who met criterion on concepts measured by the pretest items also met criterion on these same concepts on the posttest. Of the students who were branched over any instructional section, all met criterion on those concepts on the posttest. These findings implied that the use of this pretest was a wise and justifiable strategy. The review options given to students who met criterion and were branched over instructional materials allowed for closure of the information and made the branching strategy acceptable.

Problems of branching based on pretest performance. Several problems surfaced during the operational run of the program. One problem was in the construction of the pretest items and in the programmed "correct" responses. It was likely that some students were penalized because of a correct but unanticipated and consequently unaccommodated response set. In addition, some answers were so stringently programmed for that misspelled words or syntactic deviances were recorded as incorrect.

The duplication of student performance, which resulted from students being "taken back" through a pretest question because of some technical difficulty posed still another problem. The elimination of such duplication from the records required a manual sorting of the data which was a laborious and time-consuming process.

Since the pretest was often the first experience at the computer terminal for many students, some problems encountered during the pretest may have been a direct result of a student's lack of sophistication with the system.

Some programming "bugs" were not detected until the actual run of the pretests with the validation group. These "bugs" were removed as promptly as possible; but some students were penalized because of them. For example, one part of an audio message was muffled and students had to respond to what they "thought" they heard. Consequently, several responses to the question about the audio message were incorrect.

Two students shed light on the "guessing" factor inherent in any testing situation. These students stated that they had guessed on some questions and were branched over information which, in fact, they did not know. The built-in review options could have served as the precautionary measures against leaving the course without getting the information. Too, the contingency hierarchy, which required completion of the highest item in a particular sequence in order to forego instruction, was designed as a safeguard against guessing. Some students may have guessed because there was no answer alternative for lack of knowledge.

Usually all course segments were available for student instruction. However, because of systems breakdowns, sometimes only selected segments could be made available in that prior committment for disc drives had been made. If a student was scheduled for instruction and his segment was not available, the student had to be skipped out of his preestablished instructional sequence based on his pretest performance and placed into the available segment. In order to place students in these instances, complex programming adjustments had to be made.

Although not of the problem type, another factor of note warrants mention. The course is so designed that it will not execute for demonstrations or reviewing without a pretest record. Consequently, if a person wanted to preview the course, he would first have to take the pretest so that he could be branched into the appropriate sections.

Pretest performance as indications of preservice teachers' phonics knowledge. Pretest data revealed that the phonics knowledge of preservice teachers, without instruction, was far from substantial. The conclusions drawn in the literature about the status of preservice teachers' phonics knowledge and the inadequacy of most reading methods courses to provide the intensive instruction warranted by the scope of phonics content, were supported by both the pretest results and by the amount of instructional time afforded the individual student.

The conclusions and implications related to preservice teachers' knowledge in general areas of phonics content are presented below.

Phonics readiness. More than 70 percent of the preservice teachers were unfamiliar with the readiness factors which are important to a child's success in phonic analysis. Without an awareness of these readiness factors and how they relate to phonics learning, many teachers will make little preparation for providing the necessary instruction in the readiness areas. A likely consequence will be that many children will be thwarted in their attempts to learn phonic analysis because they will not have been trained in the prerequisite skills.

Consonant letter combinations. Since only 20 percent of the students knew the distinguishing quality of consonant blends and only eight percent demonstrated knowledge of the sounding attribute of consonant digraphs, it may be concluded that without intensive training in phonics, teacher knowledge in this area will be minimal. Such minimal knowledge implied that efficiency in teaching children the letter-sound relationships in the consonant letter combination area will also be minimal. Teachers, once on the job, will not be fully effective in teaching their learners the differences in the sound qualities of these combinations.

Generalizations governing vowel sounds in words and related syllabic principles. The findings in this area led to the conclusion that without instruction, preservice teachers will go into the classrooms very limited in their ability to teach children the generalizations governing vowel sounds in words. Most of the teachers will be familiar with y as a vowel but will be unable to communicate the rules governing the sounds y represents.

Vowel-letter combinations--digraphs and diphthongs--comprised another area in which preservice teachers possessed inadequate knowledge. Without more intensive training provided by methods courses, these teachers will have to resort to "telling" learners words instead of teaching principles by which learners might themselves unlock new words.

Consonant and vowel irregularities. Preservice teachers appeared to be more knowledgeable about consonant irregularities than with any other phonics content. It was concluded, however, that they would have to develop skill in accurately communicating the principles to children. Vowel irregularities would pose a greater difficulty for teachers. Without training, most of these teachers would at best, only be familiar with "terms;" they would not know to what the terms referred or how to effectively communicate this content to children.

Scope and sequence for presentation. Since the preservice teachers were so unfamiliar with the content, it was logically deduced that they could not order it in an acceptable hierarchy for presentation. While it is true that both the order and the explanation of the phonics principles to be taught are provided in the most widely used basal readers, it is likely that teachers will only parrot the content of the readers and not really teach phonic analysis to their children. In addition, when children are reading without basal readers, and encounter phonetically regular words, the teachers must know the principles governing the sound or they will resort to telling the child the word. The same is true if a group language-experience story or other reading activity is planned. Teachers will not be able to consult their notes or texts in every situation and will consequently ignore several opportunities for teaching or reinforcing letter-sound relationships in meaningful situations.

Another implication from teachers' limited knowledge with the scope and sequence of the content was that they will teach a class rather than meet individual student needs. Some of the learners in a classroom will need phonics readiness training; others will be sophisticated enough for syllabic principles and accent rules. If the teachers are dependent on the teacher's guide, they will only succeed in helping those learners whose needs happen to coincide with the information presented in the teacher's manual.

Principles and procedural steps. It was concluded that because so little about phonics content and principles was known, that preservice teachers did not have, and would not have without instruction, a flexible format that could be used to introduce almost any letter-sound relationship. Such a format, at the teachers' fingertips, would provide the teachers with a structured approach that would insure that the objectives for introducing letter-sound relationships would be met.

The principles for teaching letter-sound relationships would be another area in which preservice teachers would be limited without instruction. Without an understanding of the principles for introducing letter-sound relationships, many of these teachers would make errors in teaching that might be harmful to some children. For example, if a teacher was not aware of the principle of sounding letters in words, and exaggerating but not distorting the sound, she might teach the child to "sound" each letter in a word (i.e., buh-ah-tuh = bat). This approach to sounding results in the mispronunciation of the word and possible loss of meaning because of the mispronunciation.

Conclusions Related to Instructional Materials

The findings from the analysis of the instructional mastery items data forms imply that some review, analysis and revision are in order for portions of each instructional segment. An indepth analysis for specific recommendations, in which revisions for upgrading course materials are outlined and carried out, is not within the scope of this research. Such detailed recommendations can only follow a thorough, on-line analysis and check of the cueing and practice materials, the strategies employed in presenting the materials, the related technical functions and student comments and performance records. The conclusions from the materials analysis provide direction for the revisions analyst whose job it will be to utilize the directions in revising the course.

While specific recommendations for particular items may not be justifiable or fully valid at this point, some trends noted in the items analysis did lead to conclusions from which tangible, general recommendations were made.

The findings from the analysis did suggest that each segment provided for the mastery of most of the instructional tasks by the majority of the learners.

Conclusions from response latencies, mean number of responses, responses on first attempt. Most mastery items provided only one opportunity to respond; consequently, the mean number of responses to an item does not provide sufficient findings from which generalizations may be made regarding the subordinate cueing and practice items. However, since the items were of the mastery type, a mean number of responses greater than two (2) denoted some irregularity in the corresponding subordinate items or in the item itself.

In situations where the mean responses for a student were two with a correct response on the second attempt, it was concluded that the wording of the first stimulus was ambiguous or that the related cueing and practice materials were inadequate.

Response latencies were checked because it was conjectured that after adequate cueing and practice, light pen responses and simple keyboard fill-in or multiple choice type items could be responded to rather promptly. The analysis of the findings lends credibility to the conjecture. Students whose response latencies were greater than one minute were responding in most cases, in the keyboard multi-lined response mode, or to a self-evaluation task where some reading of and thinking about a model preceded the response.

Conclusions Related to Instructional Strategies

The self-evaluation strategy. The items analysis suggested some conclusions about the use of the self-evaluation strategy. Since the students' self-evaluations became more congruent with those of the author/instructor, the use of this strategy was deemed an effective way of providing for flexibility in learners' responses and in allowing the learner to judge the validity of his responses.

Several of the students sanctioned this strategy in their comments about specific frames, or in their final comments on the course. The popularity of this feature was corroborated by the comments of programmers who went through the course as students and by the comments from the first testing groups.

Computer-evaluated multi-lined responses. Computer evaluation of extensive-constructed or multi-lined keyboard responses is a strategy for which the full effectiveness remains untapped. The items analysis revealed wide disparity in computer-evaluated and author/instructor evaluated responses. Students were penalized in several instances because the anticipated response sets did not include their answer--even though the answer was acceptable. Another problem lay in the structure of the items within a set. In some instances the programmed sets were so rigid in spelling, syllabication, word order and exclusiveness of word choice that the students' responses were marked incorrect when in fact they were satisfactory.

If enough unanticipated responses are reviewed from the student performance records, and if they and the other factors mentioned above are accommodated, it is likely that the computer evaluation of multi-lined or extensive-constructed responses will prove to be an exceptional asset since one of the arguments for computer-assisted instruction is that the computer can be programmed to be both tutor and evaluator. In some cases, because this capability as evaluator has not been fully investigated, students are actually stifled in their attempts to respond because they are of the opinion that they must conform to a preestablished "right and only way" of stating the answer.

Illustrative lessons. Student comments revealed ambivalence toward the use of the illustrative lessons. On the one hand, most students were very receptive to the idea of being exposed to at least one way of introducing letter-sound relationships. The major complaints levied against the lessons were that the lessons were too repetitive, too numerous, and too lengthy. These complaints were judged valid. A factor which might have increased the length of the illustrative lessons for several of the students was the fact that these lessons were serial build-ups. This meant that if the student was stopped anywhere in the series because of technical difficulties, terminal schedule or lack of time, that student was taken to the beginning of the series--even though he might have been on the sixth of seven steps.

Overview of objectives for each instructional segment. Presenting the objectives at the beginning of each instructional segment was concluded to be a justifiable though not fully developed strategy. Observations of student work and notations of student comments during the operational use of the program led to the conclusion that presenting general objectives did not give students adequate, specific guidance to enable them to be selective in their notetaking or in placing their emphasis for review. It is believed that if the specific objectives had been duplicated and disseminated at the beginning of the program students would have been better able to chart their progress and partition their instruction more conveniently. In addition, the students would have been provided with a global view of instruction and would have been able to weave their own awareness of the structure of the course.

Presentation of the course objectives at the beginning of the course might also have allowed students to pinpoint specifically which objectives they had not mastered and to request review or additional instruction in the related instructional area.

Instructional time. The wide dispersion of instructional time for completion of the incourse materials attested to the achievement of individualization and to the program's adaptation to different learning rates. The disparities in instructional time may also be related to the branching process which eliminated some students from various sections of instruction and thereby lessened their instructional time. For most of the preservice teachers, phonics content, phonics generalizations, instructional principles and procedures comprised an arena of new knowledge. Consequently, the mean instructional time required by these students to learn this new material exceeded the time generally allotted phonics instruction in the usual structure of a reading methods course.

Conclusions from Posttest Findings

Since this was the first validation run of this instructional product, it was also the initial test of the effectiveness of the product on a large scale. It must therefore be acknowledged that the crux of the discussion of this first trial lies with providing guidelines for product optimization. Once the product is deemed maximally operational, then further research may be undertaken to determine how well the product functions relative to other products.

Materials validation. The posttest performance of the top 80 percent of the validation group led to the conclusion that the course, in its present form, is a valid instructional package and may be alleged to guarantee similar performance from future groups typical of the validation sample. It was also concluded that phonics content, phonics generalizations and the principles and procedures for teaching letter-sound relationships are accommodated well by computer-assisted instruction.

Several factors of note warrant some discussion here. At least four students were "recalled" because they failed to complete the posttest. Since participation in the program was voluntary, a minority of the students simply "went through" the course and expended little effort in conscientiously attending to the instruction. The course was designed as a unit of instruction for a preservice methods course and would require the same efforts for achieving the objectives as would any other formal unit of a course. Some students viewed the course as an "exposure to CAI" rather than as a learning experience in phonics from which they would be required to demonstrate competence. A situation in which the learning is more purposeful and related to the students' classroom objectives must be maintained to appropriately test the course's effectiveness under the conditions for which it was designed.

Criterion test items analysis. The conclusions drawn pertinent to each test item which did not meet the established criterion level are presented in the following discourse.

Neither of the mastery items, from the incourse items analysis, related to question 1 had difficulty levels less than 80 percent. This condition implied that the majority of the students demonstrated competence during the instruction. The test item itself appeared clearly worded with appropriate directions; hence, it was reasoned that perhaps some learners did not meet full criterion on the test item because additional reinforcement was needed in the program.

Objective 30, measured by question 2 of the criterion test (posttest) was met in full by 55 percent of the students. The complete course implied the sequence for presenting phonics content, so that the analysis of no single factor would reveal judgemental information relative to the item's ineffectiveness. A closer analysis of the students' responses showed that more than 80 percent of the students attained at least four of the possible points on this question. Since this performance was close to criterion, it was concluded that more closure should be provided by the course, possibly through the list of objectives, so that students will know exactly what is expected of them.

Question 3 measured objectives three and four. Since only 64 percent of the learners met full criterion on this test item, the related mastery items analysis charts were reviewed. The difficulty levels of the major instructional tasks shown for Segment II, revealed that the items were at a difficulty level suitable for at least 93 percent of the learners. Because the test question was judged clear and the instructional materials suitable, and because 97 percent of the learners gave satisfactory definitions of a consonant blend (objective 3) it was concluded that the learners did not make use of the mnemonic devices for naming blends that was suggested during the instruction. It is likely that the objective itself warrants revision in this case. It may be, that in dealing with the names of blends, recognition, rather than recall, is a more suitable cognitive test.

Question 4 was comprised of three parts. Part a, which required defining a consonant digraph (objective 5) was met in full by 100 percent of the learners. All the digraphs were named by 22 or 61 percent of the learners; but only 17 or 47 percent responded to part c which required that they give the letter which represented digraph sounds that were not the same letters (or in the same order) as those making up the digraph. The instructional items for part b (naming digraphs) were reviewed. Several of the items (cf33a blr, cf33b blr, cf33c c7r) were starred as having undesirable difficulty levels. In as much as the instructional items relating to the task were all at a satisfactory difficulty level, it was concluded that the test question was poorly worded and faulty.

Question 6 measured objective 9 and required that the student state the generalization for short vowel sounds in words. In light of the fact that 24 of the students met full criterion and 34 met partial criterion, and because the instructional items related to this objective were all at a satisfactory difficulty level, it was concluded that neither the test item nor the instructional items were faulty. No revision was deemed necessary.

Question 8 measured objectives 10 and 11. The instructional items for both objectives were reviewed in that only 14 percent of the learners met full criterion. Unsatisfactory difficulty levels were noted in 11 of the 21 mastery items. This situation suggested that the instructional sections dealing with these concepts are weak and warrant revision. The posttest item also appeared to need revisions.

Questions 10, 11 and 12 dealt with the generalizations governing long vowel sounds in words. Question 10 (objective 13) was answered by 18 of the learners; 12 learners named at least four of the five features tested for. Since 83 percent of the learners presented this number of the features tested for, and since the instructional items related to the incourse efficiency had a difficulty of 83 percent, the instructional section was viewed as satisfactory and it was concluded that more concise questioning was in order.

The same type of response trend cited in question 10 was evident in question 11, which measured objective 14 and in question 12 which measured objective 15. The learners demonstrated understanding of the concepts during instruction but did not meet criterion on the test item because of the omission of one feature.

Question 16 measured understanding of the soft c and g rule. Eighteen students met full criterion; six omitted only one feature and met partial criterion. Since the difficulty levels of the instructional sections were all 100 percent, it was concluded that most students had derived the rule satisfactorily during instruction. However, the fact that these learners had not conditioned thoroughly to all the features implied that some revision of the instructional materials is in order.

Criterion test item 20 measured achievement of objective 25. A review of the test item judged it clear and sufficient for measuring attainment of the objective. The mastery tasks for the instructional analysis showed an unsatisfactory difficulty level; only 71 percent of the learners presented the task demonstrated mastery on their last attempt. It is justifiable to conclude that the materials for practice and mastery of this concept are inadequate.

Criterion test item 21, which measured achievement of objective 26, did not meet the established criterion. An analysis of both the incourse mastery items and of the test item itself revealed factors that are implicative of the inefficacy of the incourse practice, cueing and mastery items.

All of the mastery items related to question 22 recorded difficulty levels at or above the 80 percent level. Since the instructional items are satisfactory and since 88 percent of the learners met at least partial criterion (i.e., omitted no more than one feature) it was concluded that the discrepancy lies in the structure of the test item and not in the instructional materials.

Question 23 measured the students' ability to discriminate oo sounds in words. In that 30 or 83 percent of the learners did identify the long and short sounds correctly, and since the difficulty levels for all but one of the practice/mastery items were satisfactory, it was concluded that the instruction was effective but that the test item, when requesting the student to use the label "neither" was testing a concept which had not been emphasized during instruction. In addition, since the learners had become sensitized to sounds, many of them failed to write neither and attempted to identify it as one of the sounds represented by a letter or a letter combination that had been studied in the course.

The difficulty levels for the instructional items related to the objective tested in question 24 were judged satisfactory and the test item was felt to be appropriate. In addition, the majority (33) of the students demonstrated at least partial competency on the task. In light of these factors, it was concluded that additional practice during instruction might be the remediating influence.

Question 25 did not meet the 80 percent criterion level. A review of the test item rendered it appropriate for measuring objective 32; however, the review of the difficulty levels of the instructional checks revealed that although the principles were stressed during the illustrative lessons, and were pointed out and reviewed on several occasions, the students had not had adequate practice in noting instances in which the principles were adhered to and writing the principles themselves. It was concluded that many learners did not meet criterion fully in citing the principles for phonics instruction because they had not had the necessary advanced organizers (i.e., items for practice that are smaller renditions of the larger mastery task) relative to the behavior required in the criterion test item.

Although only 26 or 70 percent of the students met full criterion on question 26, an additional eight learners listed five of the six features tested for. Since 94 percent of the learners included at least 80 percent of the features tested for, it was concluded that the item was satisfactory. A review of the mastery items from the course materials analysis led to the conclusion that the practice and mastery items are sufficient but that additional reinforcement may be beneficial.

Conclusions from the Operations Analysis Findings

In view of the findings from the operations analysis, it was concluded that there were flaws in the development and running of the Phonics Program that negatively affected the course and caused errors which could have been avoided had the operations been more carefully planned and coordinated.

It was also concluded from the operations analysis that lack of communication between the author and the technical personnel caused several "bugs" in the program. In addition, it was concluded that the lack of a definite budget places a project at a decided disadvantage during the beginning stages of its development and during the testing and revision trials.

Summary

It was concluded that the development of this CAI Phonics Program was an imperfect, but earnest attempt to provide individualized instruction in phonics to preservice teachers. The general conclusion drawn is that the combination of the instructional materials, the instructional strategies and tactics provided for a course which was effective and appropriate for the listed objectives.

Recommendations

The recommendations are listed under the same general headings as the conclusions. The recommendations were generated from the conclusions drawn from the findings and from the writer's personal experiences in developing a CAI program and running a study in a computer-assisted laboratory.

Recommendations: branching based on pretest performance.

It is recommended that the pretests be maintained as a part of the Phonics Program. The pretests appear to be reliable measures of a student's familiarity with a concept and eliminated unnecessary instruction for students who had demonstrated competence with a concept.

It is recommended that poorly written pretest items be rewritten so as to provide more structure to the stimulus and that the answer processing be updated so that spelling errors, misplaced lightpen responses and undesirable keyboard responses may be accommodated.

The technical difficulties cannot be avoided; it can only be suggested that alternatives for dealing with such difficulties be known and used.

It is recommended that the problem of undesirable responses during the pretest be alleviated by having a specially designed "How To" section written for the Phonics Program.

It is further recommended that the students be instructed at the beginning of the pretest to type "don't know" to multiple letter or multiple lined responses; and that with multiple choice items, a "don't know" choice be added. Feedback could be programmed especially for this input and save the student unnecessary time.

The final recommendation for the use of the pretest and the branching strategy is that they be used again with the suggested revisions.

Recommendation for upgrading preservice phonics training. The one recommendation generated by the conclusions from the preservice teachers' knowledge of phonics is that intensive, individualized phonics instruction be a part of the reading methods course. It is recommended for those institutions having the IBM 1500 facilities that the CAI Phonics Program be implemented as a unit for preservice reading methods courses so that larger samples may test the course and thereby advance course optimization. It is also recommended that the course Documentation be used to generate some alternate plan for individualizing phonics instruction for those institutions that do not have computer facilities.

Recommendations for incourse materials. The one recommendation encompassing the items analysis for each segment is that each starred item on the items analysis chart be reviewed and analyzed. The final scheme for materials revision will be up to the individual revisionist.

However, it is strongly suggested that the mastery item and the cueing and practice items be grouped. The first check should be in the domain of the cueing items; if no discrepancies are noted there, the practice items should then be reviewed to make certain that enough of the appropriate kinds of practice are provided for application and reinforcement of the concept. If the mastery item does not have parallel remedial materials available, it is recommended that remedial loops be added and that students be branched to the remedial instruction until their first response to the mastery item is satisfactory. If remedial loops are available, then these loops warrant some investigation.

The recommendations above apply to all starred items on the items analysis forms. A search of the starred items on the forms in Appendix H will reveal that the markings are not limited to items with difficulty levels below 80 percent. Several items were starred because the number of correct responses on the first attempt would not have rendered a satisfactory difficulty level. Ideally, mastery of a task should be demonstrated on the first attempt if cueing and practice materials are appropriate.

Recommendations for use of instructional strategies. The recommendations for the use of the instructional strategies are enumerated below:

1. It is recommended that the self-evaluation feature be maintained in this program and that further investigation be made into its viability for this program.

2. It is recommended that the answer processing for the Phonics Program's computer-evaluated multi-lined responses be

continuously updated and that this computer capability be researched with the Phonics Program so as to generate a possible prototype of set development for computer-evaluated multi-lined responses for this and other programs.

3. The recommended revisionary tactic for the illustrative lessons is to present the first illustrative lesson, stress the procedures and principles, acknowledge the commonality of the procedures and principles for all phonics content, and then provide the students with the option to review ensuing lessons. The mastery check on the procedures would of course be maintained; then if a student did not demonstrate mastery of the incourse task, the additional lessons would be, for that student, a part of his remedial loop.

4. It is recommended that the students be given copies of the course objectives after taking the pretest so that they might have a more specific supplement to the general objectives presented with each instructional segment.

Instructional time. It is recommended that the instructional time required by the validation group be a consideration in future course testing and scheduling. In addition, it is recommended that the students taking the course be taught to read the "anticipated hours" printouts so that they will have a more definite idea of the amount of time they will need in the instructional program based on the time for completing the first segment.

Recommendations for postcourse materials. The recommendations deemed justifiable for posttest materials are enumerated below.

1. It is recommended that more emphasis be placed on the concept of a logical sequence for presenting phonics content during instruction. It is also recommended that the test item (question 2) be revised and clarified.

2. It is recommended that objective 4 be rewritten to require recognition rather than recall and that the criterion test item (question 3) be revised accordingly.

3. It is recommended that the instructional materials for question 4 be rewritten according to the investigation of the revisions analyst, that the objective be rewritten to require recognition rather than recall. It is also recommended that the test item be revised to measure the new objective.

4. It is recommended that for all items which are scored according to features present, that the features to be tested for be made known to the students prior to the posttest (possibly through the objectives or possibly as a prelude to instruction). This recommendation applies to all test items which measured competency in stating generalizations, in defining elements or in describing the qualities of sounds.

5. It is recommended that the posttest items which are scored according to features present be more in the form of completion questions rather than the present short answer question.

6. It is recommended that the instructional materials related to definitions, descriptions, and in statements of generalizations be reviewed to insure that all the necessary cues are present for stabilizing the features tested for.

7. It is recommended that question 22 be restructured to ask for specific features.

8. It is recommended that the word in which the oo combination represents neither the long nor the short sound be removed from the test item.

9. It is recommended that the posttest be broken down into sections according to the instructional segments and that students be tested at the completion of each segment with smaller tests rather than with the longer test during one session.

Recommendations resulting from the operations analysis. The recommendations from the operations analysis are enumerated below:

1. It is recommended that a very close working relationship with all personnel be established at the outset of the project.

2. It is recommended that a close working relationship be established with other project directors and coordinators so that maximum cooperation may be maintained. This would upgrade efficiency in production areas where personnel are responsible to all projects and would make for better scheduling and terminal usage.

3. It is recommended that all projects have definite assurance of funding before course development is begun.

4. It is recommended that all changes in audio, images, or programming be noted in written, dated communications between the author and programmer.

5. It is recommended that no last minute changes in programming be suggested by the author unless adequate time for testing is available.

6. It is recommended that at least six weeks advance notice be given for the final production of image reels.

7. It is recommended that a minimum of three weeks be allowed for final audio reel production.

8. It is recommended that the course author be trained to make simple, on-line corrections, that he be thoroughly familiar with the capabilities and functions of the system, and that he be knowledgeable of the duties of related personnel.

General Recommendations for Future Research

The implications for future research are confined for the most part to the Phonics Program. That is to say, the research suggested will be towards course optimization. It is recommended that the course be field tested with the specific recommended revisions cited in the aforementioned sections and that the following conditions be established:

1. The program will be a required unit of instruction for preservice reading teachers in the reading methods courses.

2. The program will incorporate a "mastery model" whereby each student will continue instruction until full mastery of each objective is achieved.

3. The posttest will be adapted for CAI presentation.

4. The retest validation level will be 90/90.

In addition to the four general recommendations cited above for course optimization, four out-of-program research questions evolved.

5. It is recommended that some type of consequential evaluation be done with students who complete the Phonics Program in order to determine what effects the computer-assisted instruction program has on the behavior of the preservice teachers in a tutoring or classroom situation.

6. It is recommended that a follow-up project be developed to determine the retention of phonics content gained via computer-assisted instruction.

7. It is recommended that additional learning variables be correlated with computer-assisted instruction capabilities so as to generate models for optimizing the accommodation of learning modes and other individual characteristics.

8. It is recommended that the minimum number of testing groups for a CAI program be three and that each group have a minimum of 15 students who are representative of the population under concern.

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APPENDIX A

DESCRIPTION OF THE IBM 1500 INSTRUCTIONAL SYSTEM

This IBM 1500 Instructional System was designed specially for instruction. The system is located in Chambers Building at The Pennsylvania State University. The system consists of 30 instructional stations, each with a cathode ray tube display, a light pen, and a typewriter keyboard. Each station has an audio record and playback device and an image projector.

The main instructional medium is the cathode ray tube (CRT). The cathode ray tube is similar to a small television screen on which lines of text and other line drawings appear. The CRT, which is the main interface between the student and the computer, has a screen area equivalent to 640 display positions. There are sixteen horizontal rows and forty vertical columns. The random access disk provides information on the screen in microseconds. The learner may respond by using a light pen device which is attached to the CRT or by typing in an answer on the typewriter-like keyboard. Four dictionaries of 128 characters each can be used either for programming or for a student's response.

Another medium for presenting course materials is the IBM 1512 image projector. The projector accommodates 16mm microfilm reels and can show 1,000 still photographic images in both black and white and color.

The IBM 1506 audio play/record unit plays pre-recorded information from four-track magnetic tapes. The audio messages are coordinated with the other instructional presentations and allow the student to record responses which the student can compare to models or which may be analyzed after the student has completed the course.

The central processing unit (CPU) is the main support equipment and provides storage of data. The 1442 card/reader punch is used to input course content from punched cards and to punch out previously stored course content. A 1403 printer lists course content for use by a programmer or instructor. The 1133 multiplexer coordinates disks, tapes, and the instructional devices. The 1502 station control unit relays messages from the instructional stations to the central processing unit. There are two 2310 disk storage drives. Disks containing magnetically stored data operate in these disk drives. There are also two 2415 tape drives which store such data as student performance records. The 1518 typewriter is an input device much like the keyboard on the 1510. It can also type out course information on paper. The 029 card punch is used for punching codes on standard data processing cards.

The CPU, which can accommodate up to thirty-two student stations with these four instructional devices, contains 32,786 sixteen-bit "words" of core storage. The 2310 disk drives, which store usable course information and operating instructions, consist of 2,560,000 characters. The core storage cycle time for the tape drives which record the interaction between the program and the student for later analysis and course revision is 3.6 microseconds. The read/write time for disk storage is 27.8 microseconds per word.

Since the computer can record and recall student responses (the number of correct answers, the number of wrong answers, and so on), the sequence of instruction for a particular student can be altered on the basis of his responses. More challenging material or remedial instruction may be presented on the basis of past performance, or sections of the course may be skipped if the student's performance is at a specific level of proficiency. When a student signs on again to a course after having once signed off, he resumes his instruction at his earlier sign-off point.

The computer can be used to record a variety of information for all students, e.g., the exact contents of his response, the number of seconds he takes to respond, and his exact position in a course. Summary information such as number of correct responses to a question and total number of response attempts may be produced for analysis by the instructor, thereby reducing the teacher's clerical duties and freeing him to give individual instruction.

The computer will accept course content in two ways: 1) punched on cards, or 2) input directly from the instructional station keyboard. Using the second method, the contents of a course can be replaced, corrected, or deleted easily and quickly by special author commands.

Configuration of the system is shown in Figure 3 on the following page.

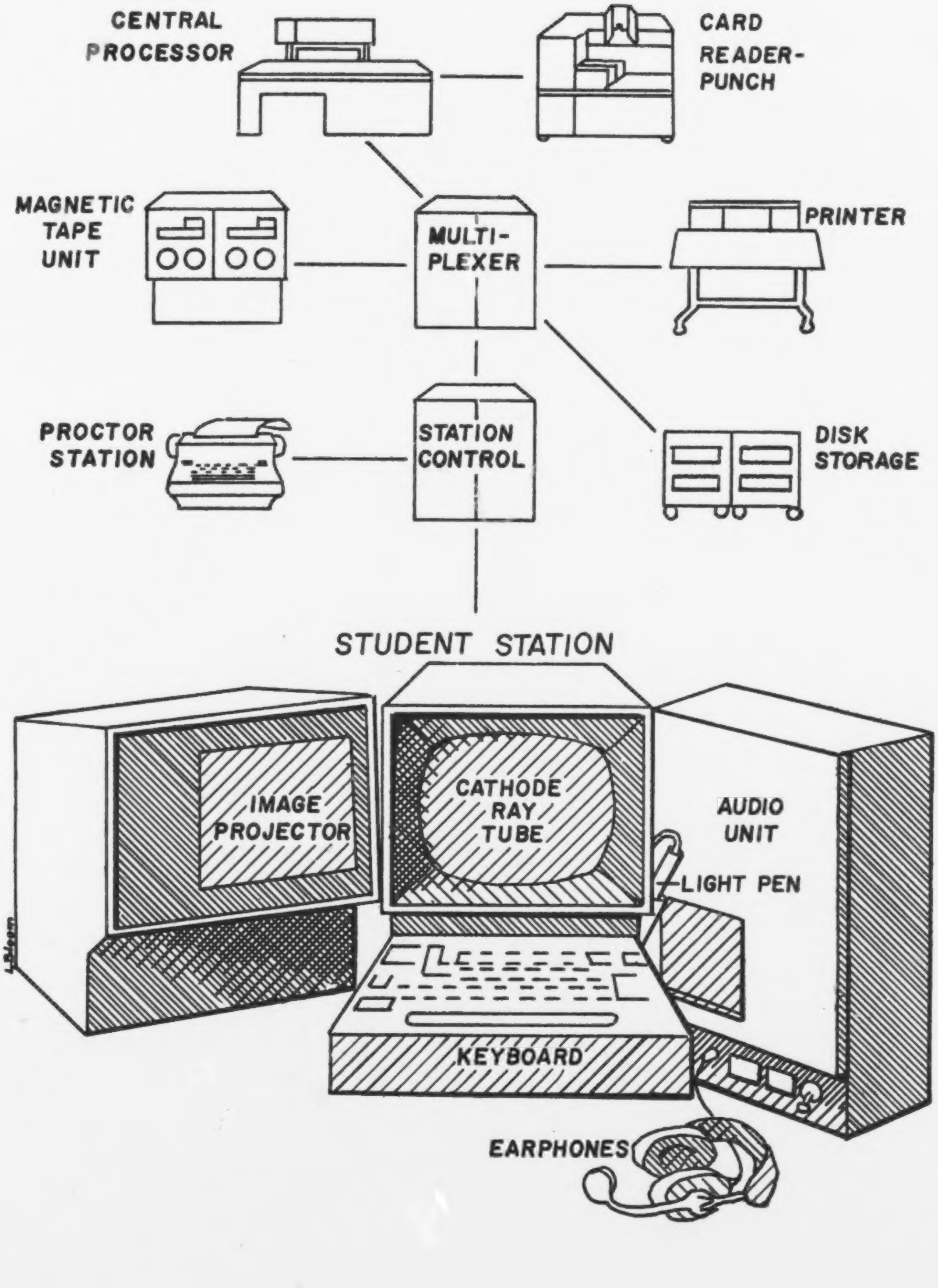

CENTRAL PROCESSOR
CARD READER-PUNCH
MAGNETIC TAPE UNIT
MULTI-PLEXER
PRINTER
PROCTOR STATION
STATION CONTROL
DISK STORAGE
STUDENT STATION
IMAGE PROJECTOR
CATHODE RAY TUBE
AUDIO UNIT
LIGHT PEN
KEYBOARD
EARPHONES

Fig. 3. Configuration of the CAI system.

APPENDIX B

SCOPE AND SEQUENCE OF INSTRUCTION

SCOPE AND SEQUENCE OF INSTRUCTION

PHONICS FOR PRESERVICE TEACHERS: CONTENT AND INSTRUCTIONAL PROCEDURES

Unit I

A. Overview

   1. Purposes of course

   2. Phonics: definition and importance of to children's success in reading

B. Readiness for Phonics Instruction

   1. Auditory discrimination between speech sounds in words

      a. explanation of auditory discrimination

      b. implications for children's success in phonics instruction

   2. Visual discrimination between printed letters

      a. explanation of visual discrimination

      b. implications for children's success in phonics instruction

   3. Sight vocabulary for phonics models

      a. explanation of for phonics instruction

      b. rationale for developing for phonics instruction

   4. Letter names and shapes as tools for communication in the teaching-learning process of phonic analysis instruction

C. Consonant Sounds: Represented by Single Letters

   1. Key words for common sound represented by single letters with more than one sound

   2. Rationale for teaching consonant sounds first

   3. Logical sequence for teaching consonant sounds

   4. ILLUSTRATIVE LESSON:

      a. procedural steps for introducing single, initial consonant letter sound

b. principles to be observed in introducing sounds

c. objectives in teaching

5. ILLUSTRATIVE LESSON: Initial consonant substitution

a. procedural steps

b. principles to be observed in letter-sound instruction

Unit II

Consonant Sounds: Blends and Digraphs

A. Consonant Blends

1. Distinguishing quality of consonant blend

2. Two-letter consonant blends: br, cr, dr, fr, gr, pr, tr, bl, cl, fl, pl, sl, sc, sk, sm, sn, sp, st, sw

3. ILLUSTRATIVE LESSON: Consonant Blend

a. procedural steps

b. review of principles observed

c. review of objectives in teaching letter-sound relationships

4. ILLUSTRATIVE LESSON: Consonant Blend Substitution

a. procedural steps

b. review of principles observed

c. review of objectives in teaching letter-sound relationships

B. Consonant Digraphs

1. Distinguishing quality of a consonant digraph

2. Consonant digraph: sh, wh, th, ch, gh, ng, ph, ck

3. ILLUSTRATIVE LESSON: Consonant Digraph

a. procedural steps

b. principles observed

c. objectives in teaching digraphs

Unit III

Syllabic Principles, Vowel Sound Generalizations

A. Syllabication

   1. Definition of process

   2. Relation to phonic analysis

   3. Rules for syllabication

      a. there are as many syllables in a word as there are vowel sounds

      b. syllables divide between double consonants

      c. single consonant between vowels usually goes with second vowel

      d. do not divide consonant digraphs and blends; treat as single consonant letters

      e. endings cle, ble, fle, gle, tle, etc., usually comprise final syllable

B. Y and W as Vowels

C. Short Vowel Sounds

   1. Key words for short vowel sounds

   2. Generalization for sounding a single vowel which does not conclude a word

   3. Generalization for a single vowel in medial position

   4. Approaches to teaching short vowel sounds in one-syllable words

   5. ILLUSTRATIVE LESSON: Short Vowel Sounds

      a. procedural steps

      b. principles observed

      c. objectives of teaching

D. Long Vowel Sounds: Single Vowel Letters

   1. Key words for long vowel sounds

   2. Generalizations for long vowel sounds

    - a. final e generalization
    - b. single final vowel generalization
    - c. adjacent vowel generalization
  - 3. ILLUSTRATIVE LESSON
    - a. procedural steps
    - b. principles
    - c. objectives

Unit IV

Vowel Letter Combinations

A. Digraphs

  1. Distinguishing feature of vowel digraph
  2. Regular or consistent vowel digraphs
  3. Generalization for sounding adjacent vowel combinations: ai ay, ea, ee, oa, oe
  4. Outline of procedural steps for teaching digraphs

B. Vowel Diphthongs

  1. Distinguishing quality of a vowel diphthong
  2. One sound vowel diphthongs: oi, oy
  3. Two sound vowel diphthongs: ow, ou
  4. Hints for sounding
  5. Suggestions for teaching

Unit V

Consonant Irregularities

A. Hard and Soft Sounds of c and g

B. Sounds Represented by s, x

C. "Silent Consonant Letter" rules: kn, ps, gh, wr, mb, bt, gn, gm

Unit VI

Vowel Irregularities

A. The schwa sound

B. R-controlled Words

C. A followed by l, ll, u and w

D. The oo sounds

E. O followed by ld

F. I followed by nd, gh, ld

APPENDIX C

COMMENT CARD AND SAMPLES OF COMMENTS FROM THE FIRST TESTING GROUP

FRAME LABEL ____________________ MEDIUM:

CRT __________

Image __________

Audio __________

COMMENTS:

SUGGESTIONS:

COMMENT CARD

EXAMPLES OF COMMENTS FROM THE FIRST TESTING GROUP

1.	aa28a	a) Too much time; give more cues b) If a person doesn't know after the first time, does he get out of it?
2.	ca09a	Simply done - good!
3.	ca03a - ca04a	Well done - clear
4.	aa78a	Why don't you give the feedback question initially rather than waiting till someone guesses wrong first? It would guide the response and save time.
5.	aa74a	Audio message was quite a bit of material to assimilate. Could it be boiled down and presented on screen?
6.	cfp01	How about a lightpen instead of keyboard response for first question?
7.	vvp02	I'm not sure whether I agree with all these constructed generalizations. I guess it depends on your objectives. Some are pretty damn hard for a retardate to construct.
8.	cf17a	Good frame - well worded and excellent feedback.
9.	ca38a - ca41a	Once again too much asked with too few guidelines!
10.	cf11a	Great teaching technique - mnemonic devices!
11.	_____	Some introduction to the pretest (reason for, etc., may help ease the shock).

12.	aa50a	Keyword technique vague; concept being described is not quite clear to me.
13.	aa51a	Too much practice; perhaps it is unnecessary to go thru each of the consonants and type a key word?

APPENDIX D

DESCRIPTION OF MAJOR COURSE STRATEGIES AND TACTICS

EXAMPLES OF STRATEGIES UTILIZED IN THE PHONI PROGRAM

A. Branching Based on Pretest Performance

With this strategy, the student was introduced to the program and given a diagnostic test based on the terminal criterion objectives. According to the results of the test the student was branched to instructional segments or to sections within segments on which the criterion level had not been attained. Chapter III contains an illustrative discussion of this strategy.

B. Student Overview of Pretest Achievement and Instructional Objectives

Broad objectives were presented to each student at the beginning of each segment. These objectives overviewed what was to be gained from the instruction. A summary of student knowledge related to the particular instructional segment and based on pretest performance was also given.

C. Student-Precision-Based Instruction Review and/or Practice

In some instances, students were given the choice of receiving a review of information already attained, of receiving additional information on a topic, or of receiving a repetition of prior information. For some tasks, the student decided whether he would skip the task or in what mode he would respond to a task. Also, much of the practice related to an instructional concept was left to the student's perception of his needs.

D. Student Self-evaluation From Model

At various points in the program, students evaluated and rated their responses based on models presented. This strategy allowed for flexibility in student responses of multi-lined, open-ended responses. A student would answer a question, formulate a generalization or principle, analyze a situation or prescribe instruction in a hypothetical situation. He would then see a model illustrating an acceptable response; in some instances, several ways of responding would be shown in the model. The student would match the idea in his response with the idea in the model and evaluate his response as being the 'same' or 'different' in meaning as the idea illustrated in the model.

E. Student-constructed Multi-lined Responses

One of the major response modes was the multi-line response mode in which a student was required to provide all of the answer to a question rather than supply words or phrases, or make correct choices from a group of items. This type of response mode forced the student to synthesize information and communicate his understanding of the information in a more sophisticated manner.

F. Computer Evaluation of Extensive Constructed Responses

In order to have the computer evaluate totally constructed responses, sets of key words which could be accepted as a part of the correct response were developed. Then the computer was programmed to accept a combination composed of one of the key words from each set as "correct." For some responses, more than forty-five key word synonyms were in a set.

G. Use of Illustrative Lessons for Demonstrating Principles and Procedural Steps

Since one of the objectives in developing the course was to provide the preservice teachers with one model for introducing letter-sound relationships to children, brief illustrative lessons were shown using different phonics content. During the illustrative lessons, procedural steps and principles observed were pointed out. The mastery task related to this area required the student to select an item and take it through the procedural steps.

H. Inductive Approach

The predominant strategy in helping the preservice teachers learn the generalizations for vowel sounds and the rules for sounding other letter combinations was inductive. The students were given the examples of the concept and then given the label. From these cues, the students formulated the generalization, description or rule. In some tasks, the learner was presented a situation and led to reason out the concept related to the situation.

I. Modified Simulation for Developing Insights

In order to develop the relationships between the readiness prerequisites and phonics instruction, the students played the role of a beginning reader. The student had to learn "sight words" from a foreign symbol system; they had to take a test on auditory discrimination; they had to visually discriminate between "words" that were similar except for one symbol.

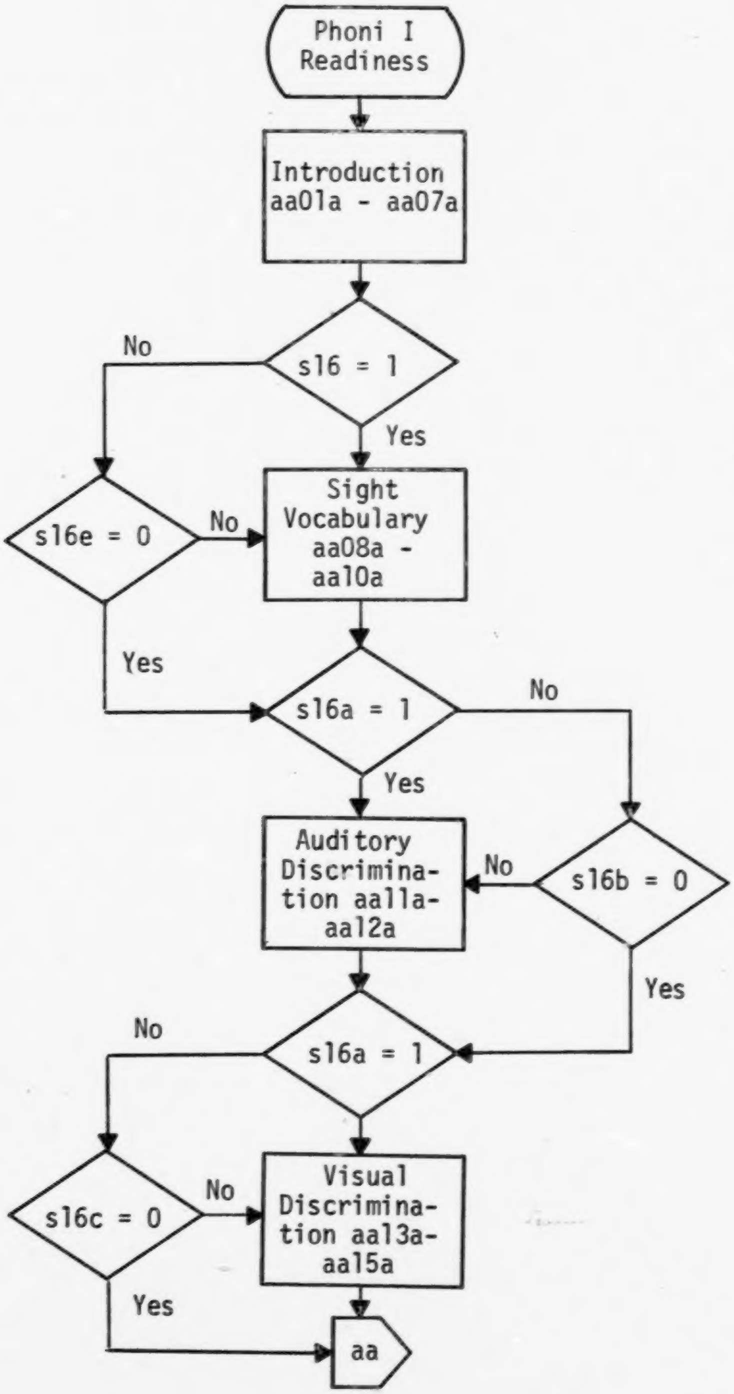
J. Wide Range of Questioning Formats

In addition to conventional response modes (i.e., multiple choice, fill-ins) the program presented several unique question formats. The multi-lined student-evaluated responses and the multi-lined or extensive constructed responses have been discussed above. Another notable questioning format is described here. This type format checks answers according to the structure; there is no right or wrong. For example, in testing a student's understanding of the vowel sound represented by y at the end of a one-syllable word with no other vowel, the edit function searched for consonant, consonant, y, or consonant, consonant, consonant, y. The possible formats were known and even if a "real" word were not typed, but conformed to the format, the student's response was judged correct. This strategy proved highly successful when used in the course.

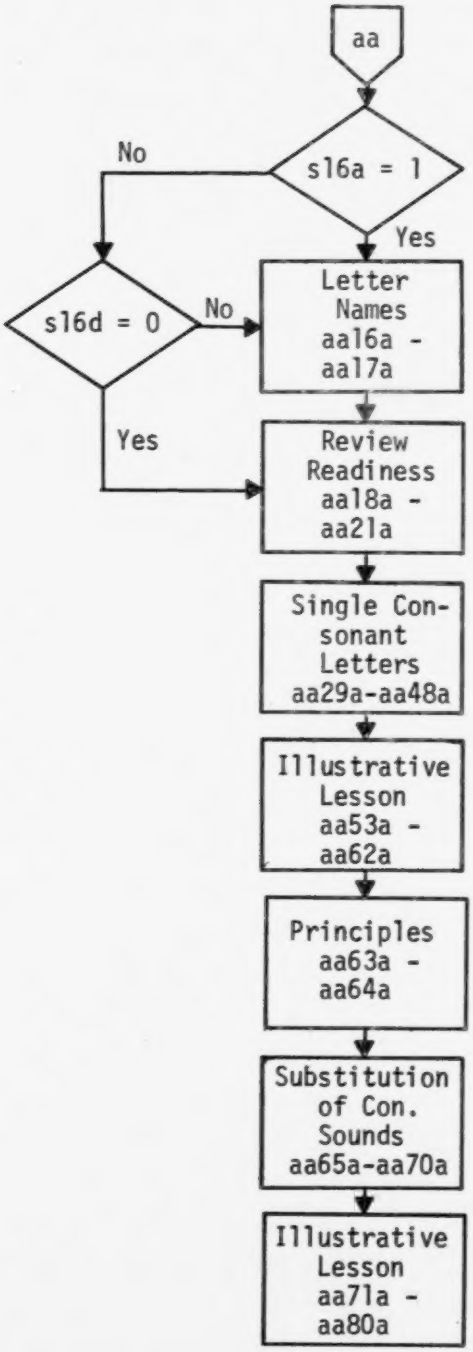
APPENDIX E

FLOWCHARTS OF PRETESTS AND INSTRUCTION

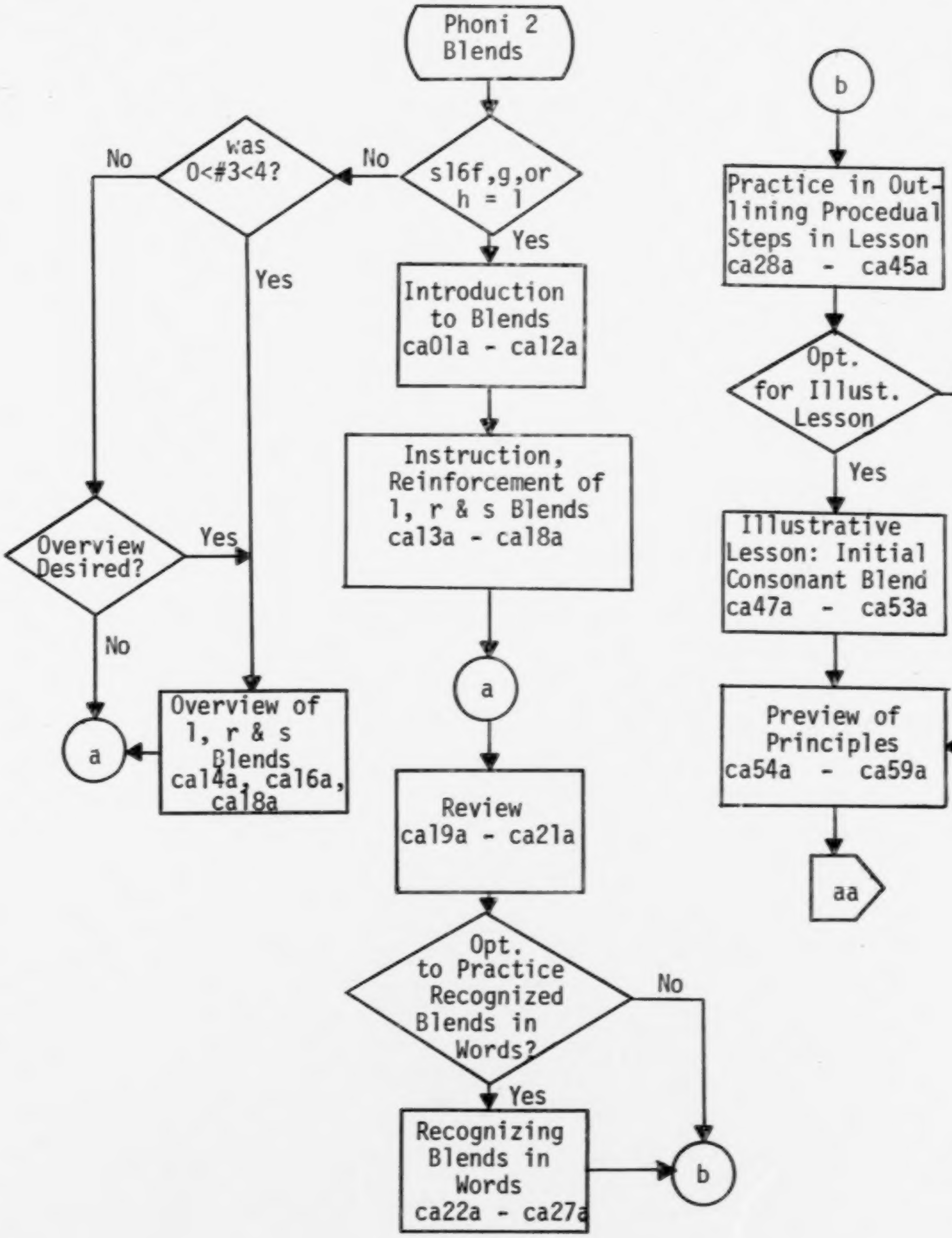
FLOWCHARTS OF INSTRUCTIONAL PROCESSES


Phoni I Readiness
Introduction aa01a - aa07a
s16 = 1
No
Yes
s16e = 0
No
Yes
Sight Vocabulary aa08a - aa10a
s16a = 1
No
Yes
Auditory Discrimination aa11a-aa12a
No
s16b = 0
Yes
No
s16a = 1
s16c = 0
No
Yes
Visual Discrimination aa13a-aa15a
aa

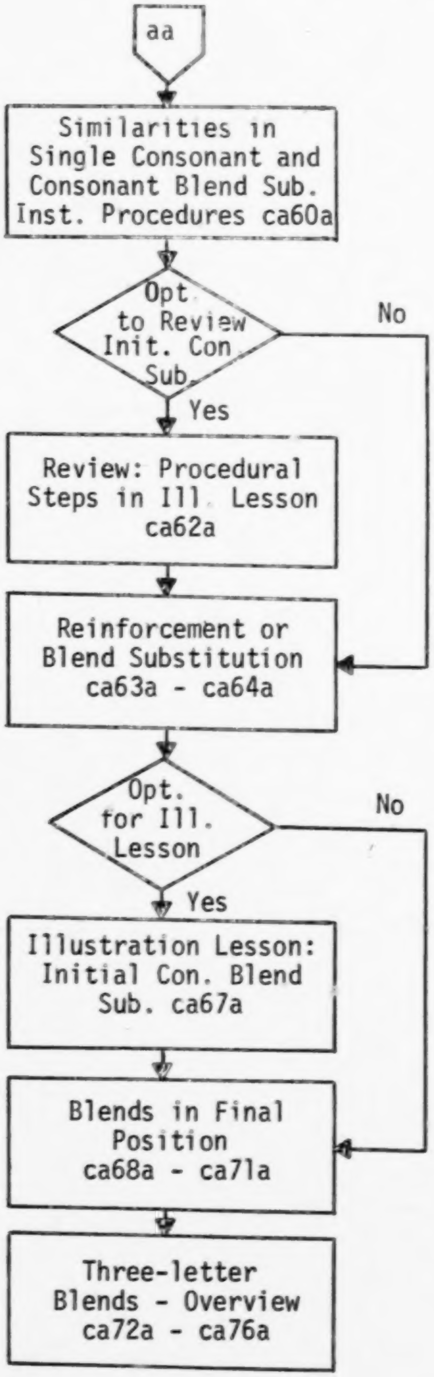
Flowchart of Instructional Process for Phoni 1.


aa
s16a = 1
No
Yes
s16d = 0
No
Yes
Letter Names aa16a - aa17a
Review Readiness aa18a - aa21a
Single Consonant Letters aa29a-aa48a
Illustrative Lesson aa53a - aa62a
Principles aa63a - aa64a
Substitution of Con. Sounds aa65a-aa70a
Illustrative Lesson aa71a - aa80a

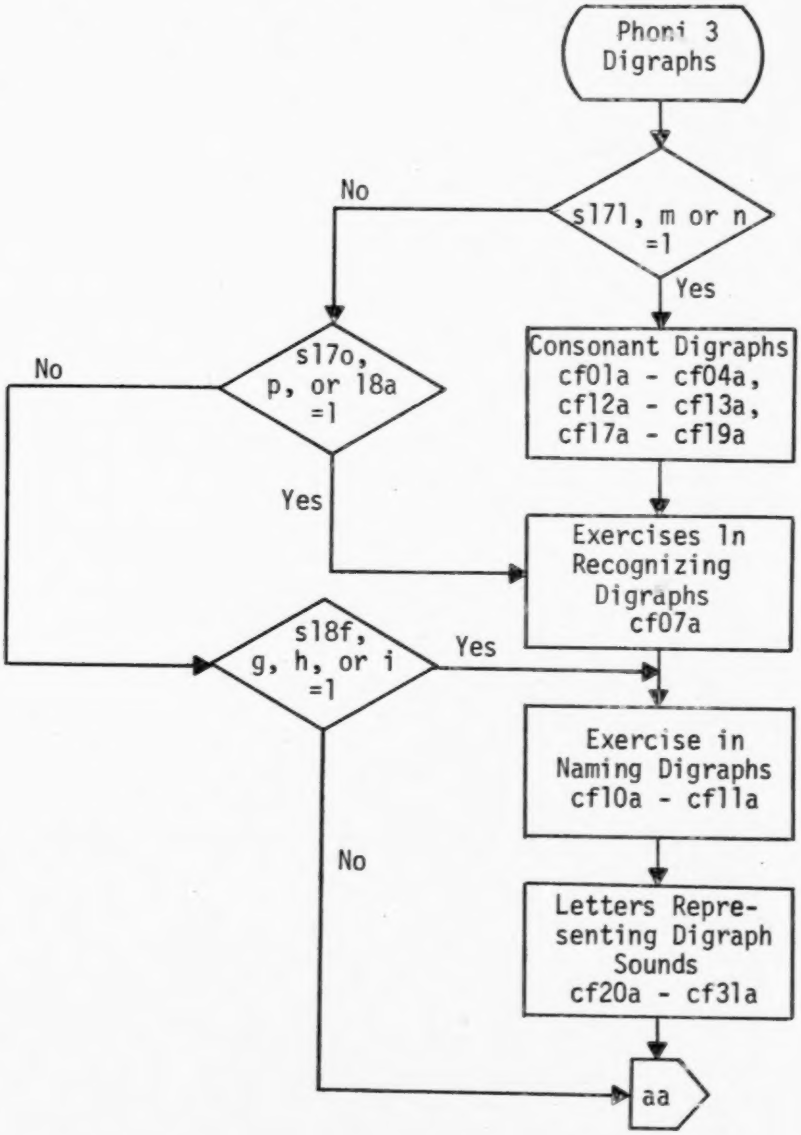
Flowchart of Instructional Process Phoni 1 (continued).


Phoni 2
Blends
s16f,g,or h = 1
No
Yes
was 0<#3<4?
No
Yes
Introduction to Blends ca01a - ca12a
Instruction, Reinforcement of l, r & s Blends ca13a - ca18a
Overview Desired?
Yes
No
Overview of l, r & s Blends ca14a, ca16a, ca18a
a
a
Review ca19a - ca21a
Opt. to Practice Recognized Blends in Words?
No
Yes
Recognizing Blends in Words ca22a - ca27a
b
b
Practice in Outlining Procedual Steps in Lesson ca28a - ca45a
Opt. for Illust. Lesson
No
Yes
Illustrative Lesson: Initial Consonant Blend ca47a - ca53a
Preview of Principles ca54a - ca59a
aa

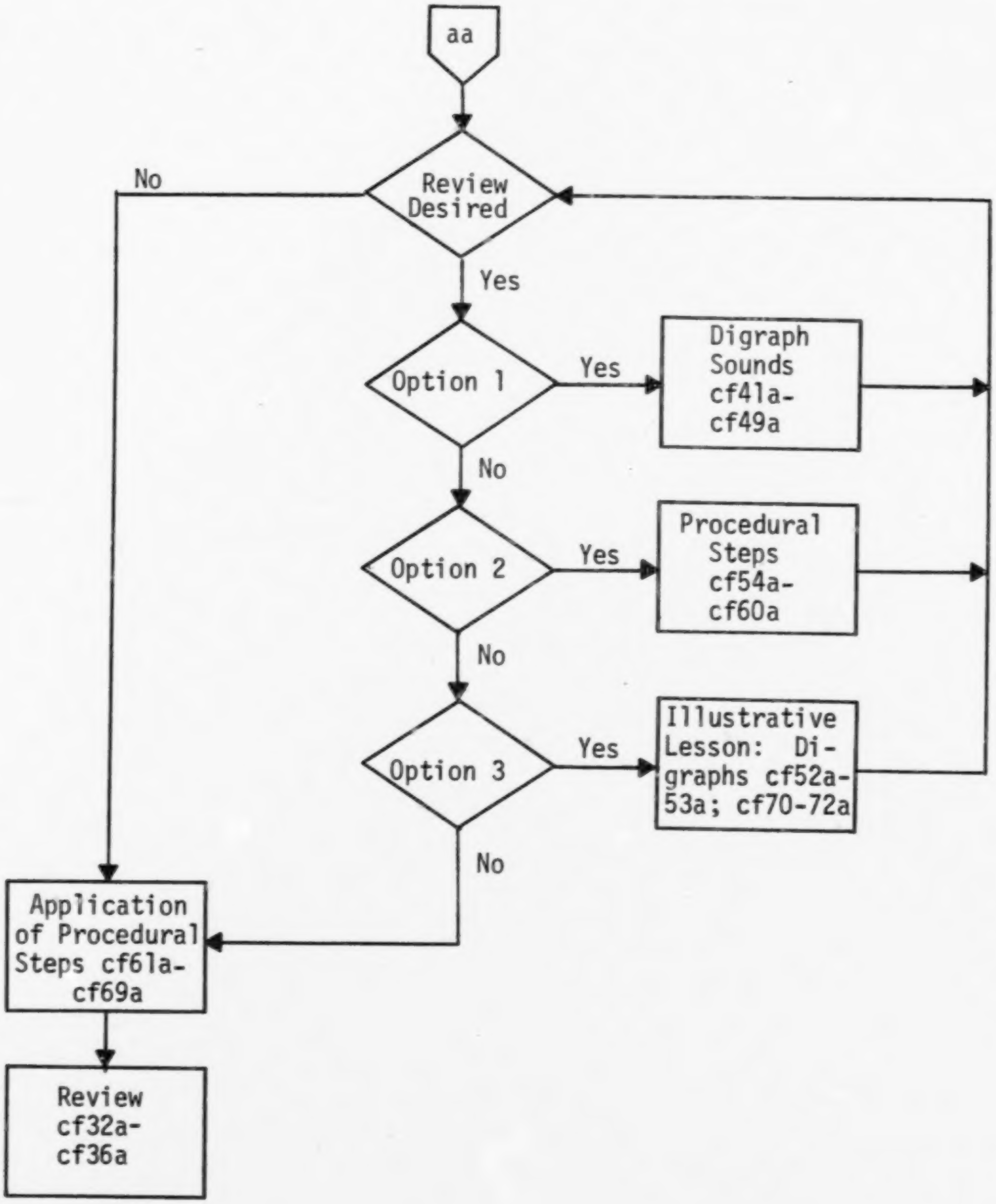
Flowchart of Instructional Process for Phoni 2.


aa
Similarities in Single Consonant and Consonant Blend Sub. Inst. Procedures ca60a
Opt to Review Init. Con Sub.
No
Yes
Review: Procedural Steps in Ill. Lesson ca62a
Reinforcement or Blend Substitution ca63a - ca64a
Opt. for Ill. Lesson
No
Yes
Illustration Lesson: Initial Con. Blend Sub. ca67a
Blends in Final Position ca68a - ca71a
Three-letter Blends - Overview ca72a - ca76a

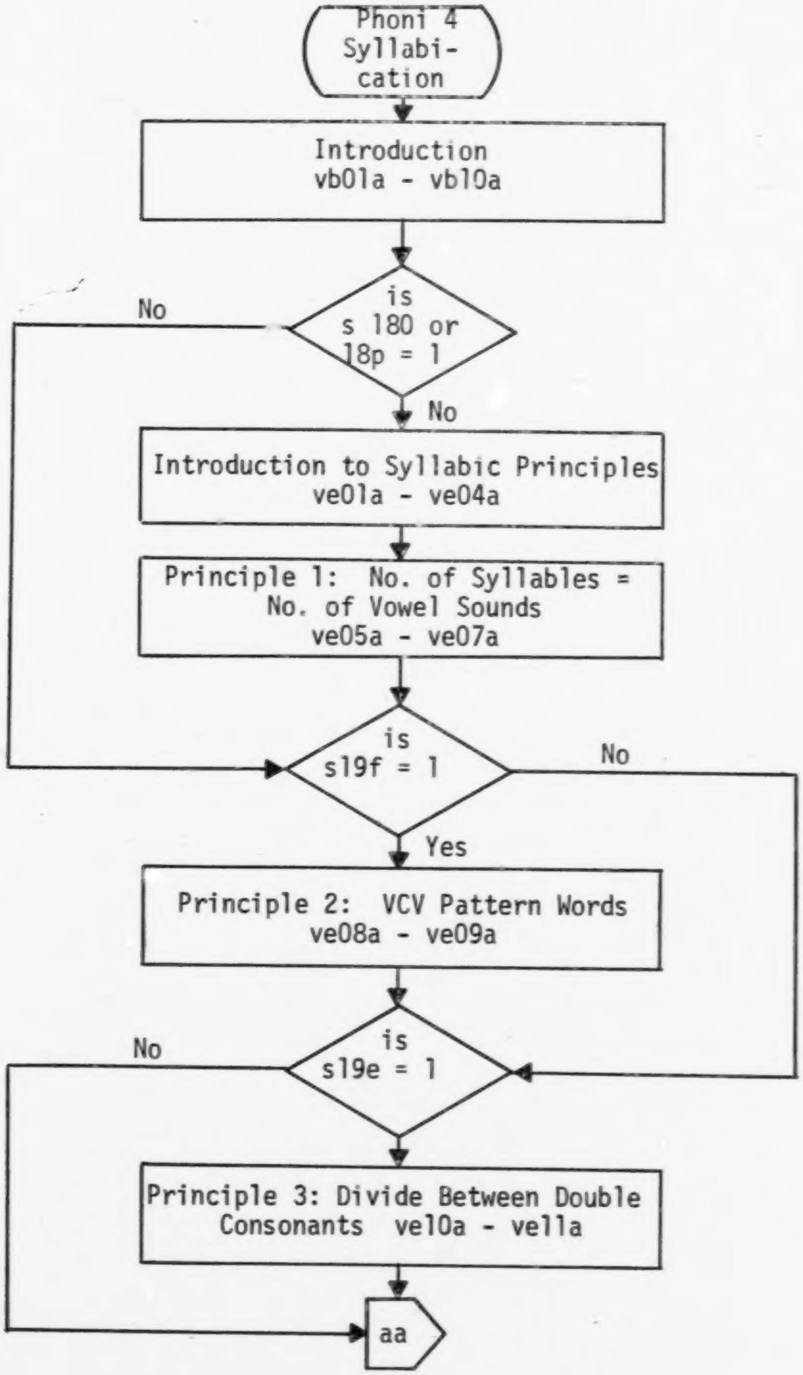
Flowchart of Instructional Process for Phoni 2 (continued).


Phoni 3
Digraphs
s17l, m or n =1
No
Yes
Consonant Digraphs cf01a - cf04a, cf12a - cf13a, cf17a - cf19a
s17o, p, or 18a =1
No
Yes
Exercises In Recognizing Digraphs cf07a
s18f, g, h, or i =1
Yes
No
Exercise in Naming Digraphs cf10a - cf11a
Letters Representing Digraph Sounds cf20a - cf31a
aa

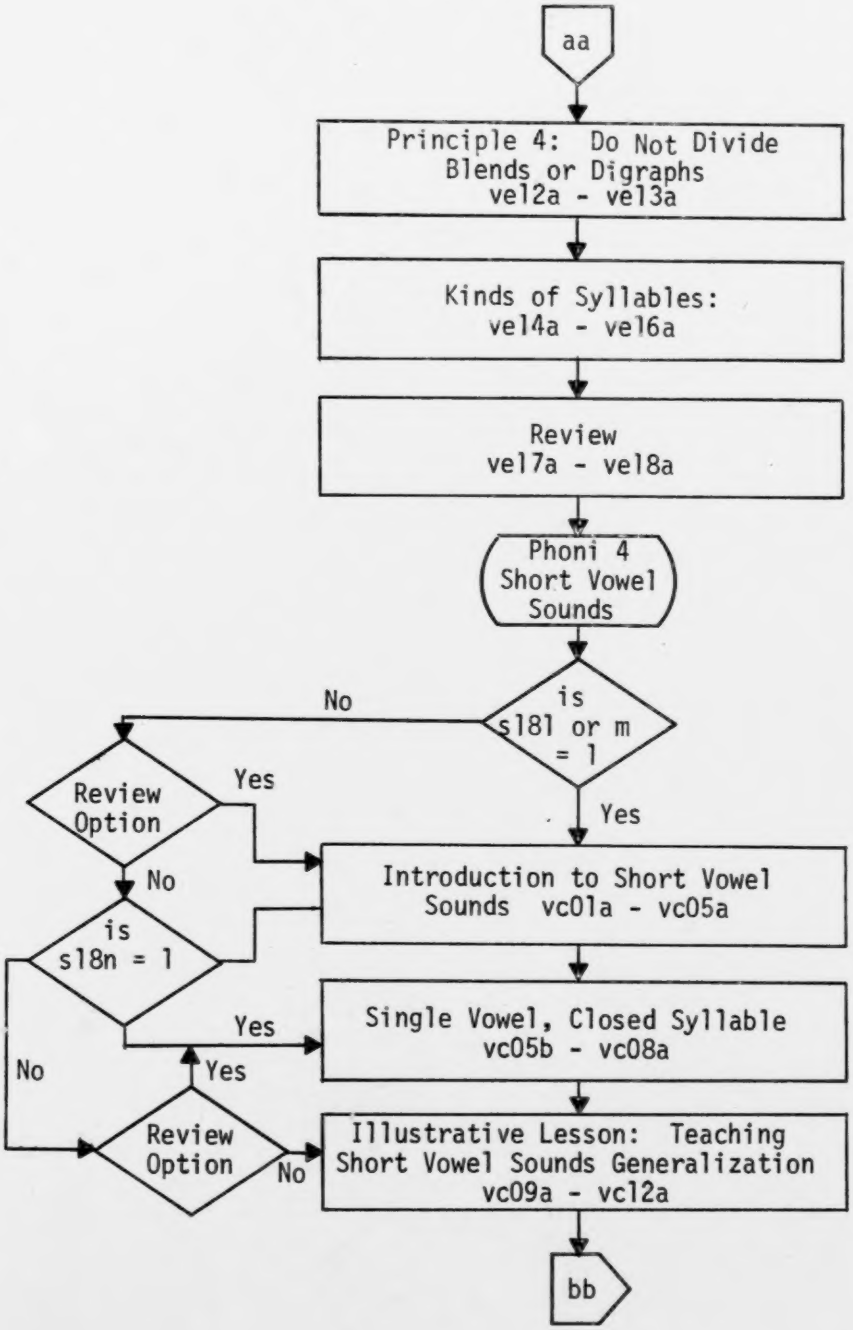
Flowchart of Instructional Process for Phoni 3.


aa
Review Desired
No
Yes
Option 1
Yes
Digraph Sounds cf41a-cf49a
No
Option 2
Yes
Procedural Steps cf54a-cf60a
No
Option 3
Yes
Illustrative Lesson: Digraphs cf52a-53a; cf70-72a
No
Application of Procedural Steps cf61a-cf69a
Review cf32a-cf36a

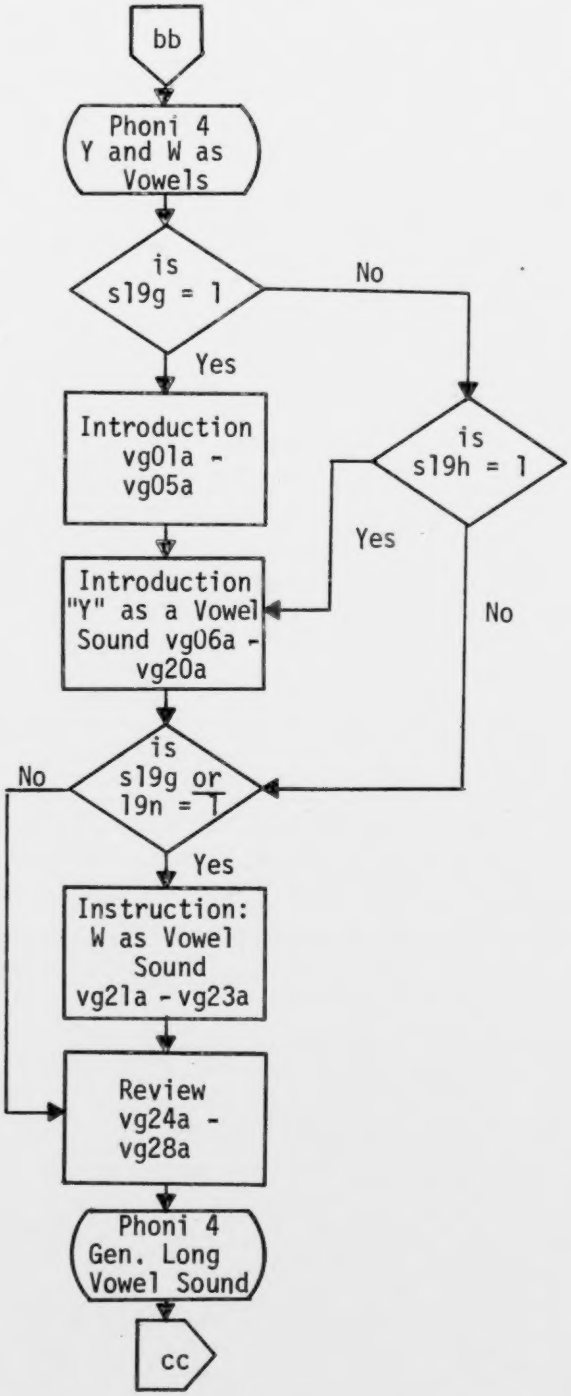
Flowchart of Instructional Process for Phoni 3 (continued).


Phoni 4
Syllabi-
cation
Introduction
vb01a - vb10a
is
s 180 or
18p = 1
No
No
Introduction to Syllabic Principles
ve01a - ve04a
Principle 1: No. of Syllables =
No. of Vowel Sounds
ve05a - ve07a
is
s19f = 1
No
Yes
Principle 2: VCV Pattern Words
ve08a - ve09a
is
s19e = 1
No
Principle 3: Divide Between Double
Consonants ve10a - ve11a
aa

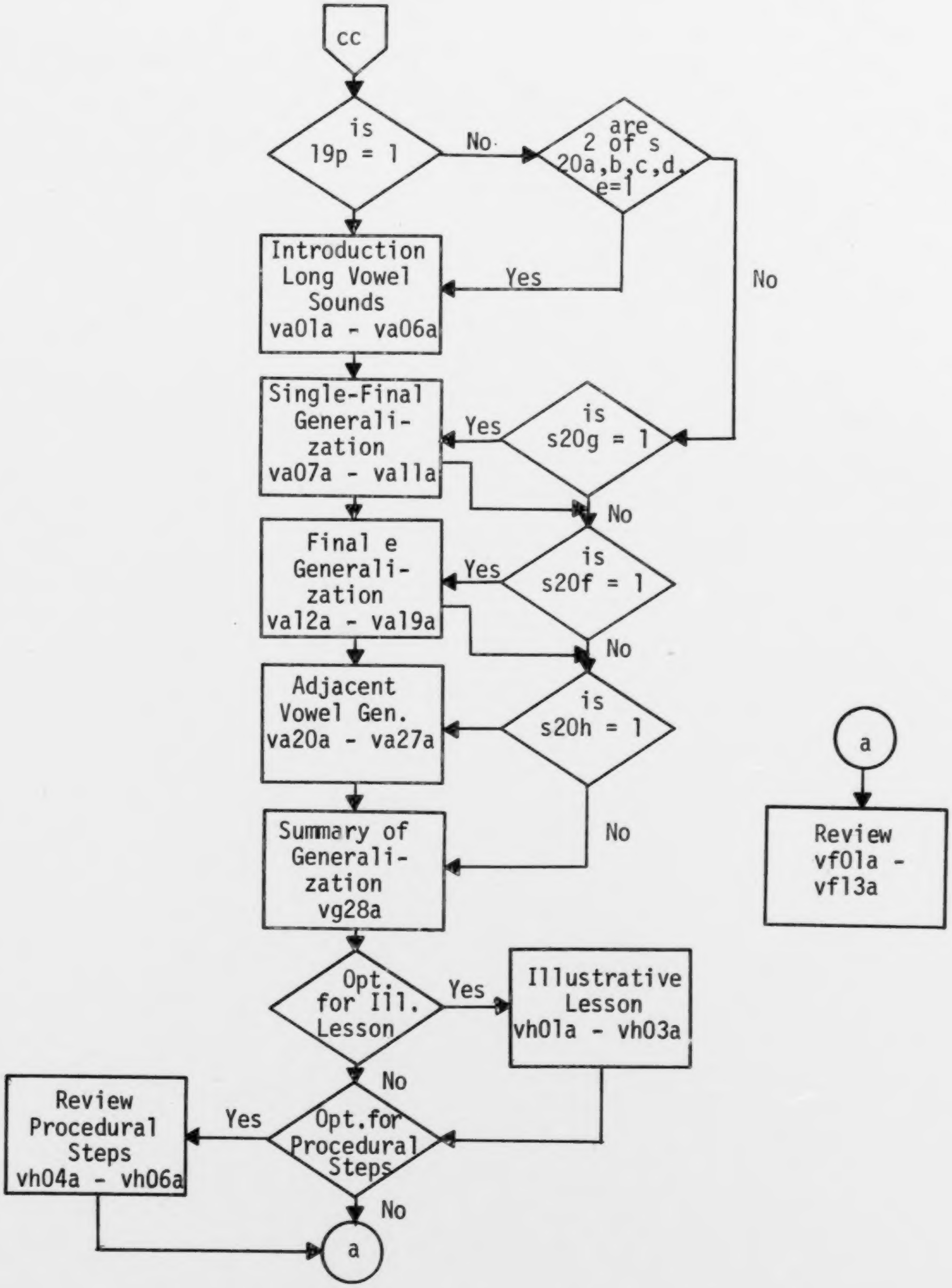
Flowchart of Instructional Process for Phoni 4.


aa
Principle 4: Do Not Divide Blends or Digraphs vel2a - vel3a
Kinds of Syllables: vel4a - vel6a
Review vel7a - vel8a
Phoni 4 Short Vowel Sounds
is s181 or m = 1
No
Yes
Review Option
Yes
No
is s18n = 1
Yes
No
Introduction to Short Vowel Sounds vc01a - vc05a
Single Vowel, Closed Syllable vc05b - vc08a
Review Option
Yes
No
Illustrative Lesson: Teaching Short Vowel Sounds Generalization vc09a - vc12a
bb

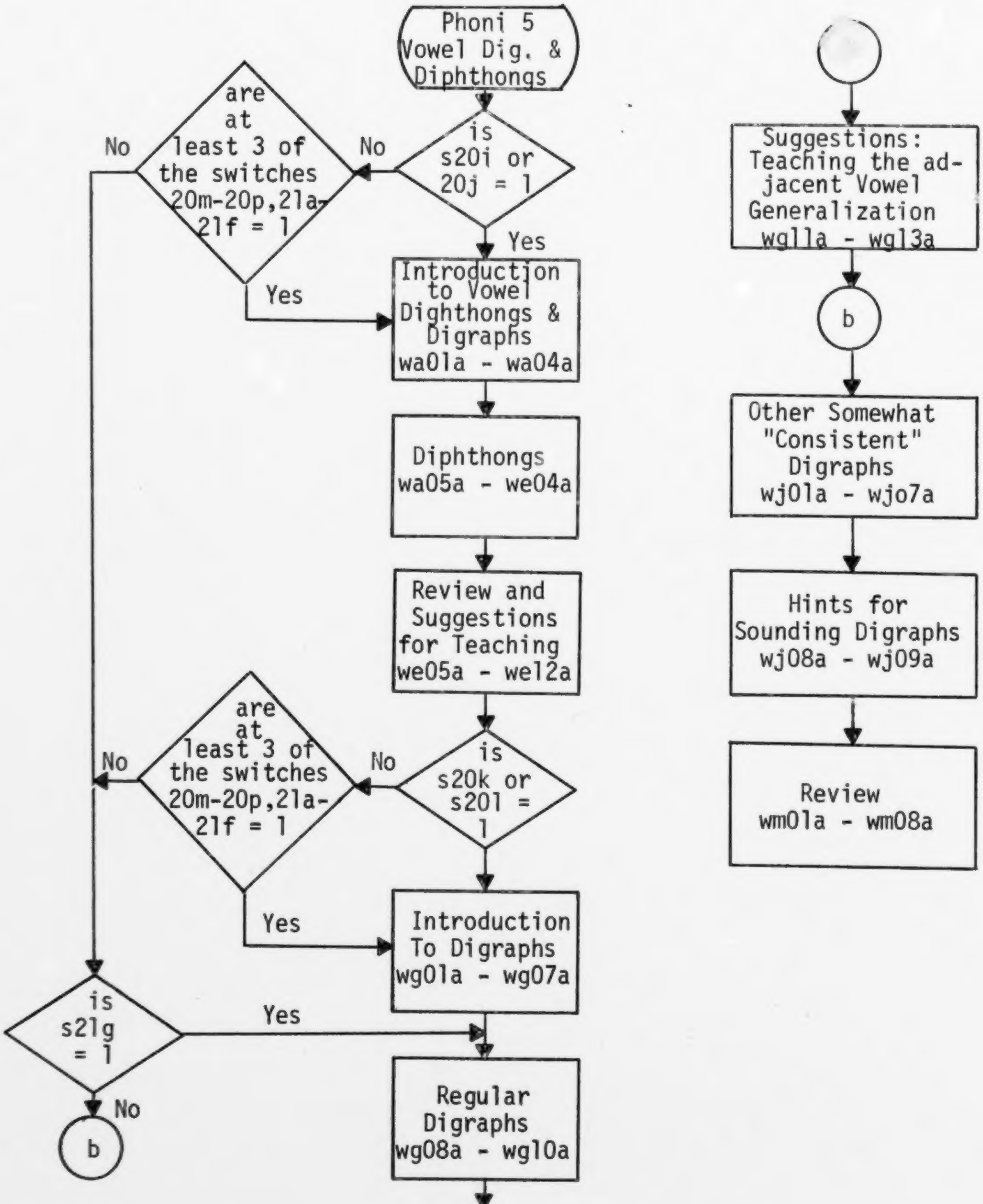
Flowchart of Instructional Process for Phoni 4 (continued).


bb
Phoni 4
Y and W as
Vowels
is
s19g = 1
No
Yes
Introduction
vg01a -
vg05a
is
s19h = 1
Yes
No
Introduction
"Y" as a Vowel
Sound vg06a -
vg20a
is
s19g or
19n = 1
No
Yes
Instruction:
W as Vowel
Sound
vg21a - vg23a
Review
vg24a -
vg28a
Phoni 4
Gen. Long
Vowel Sound
cc

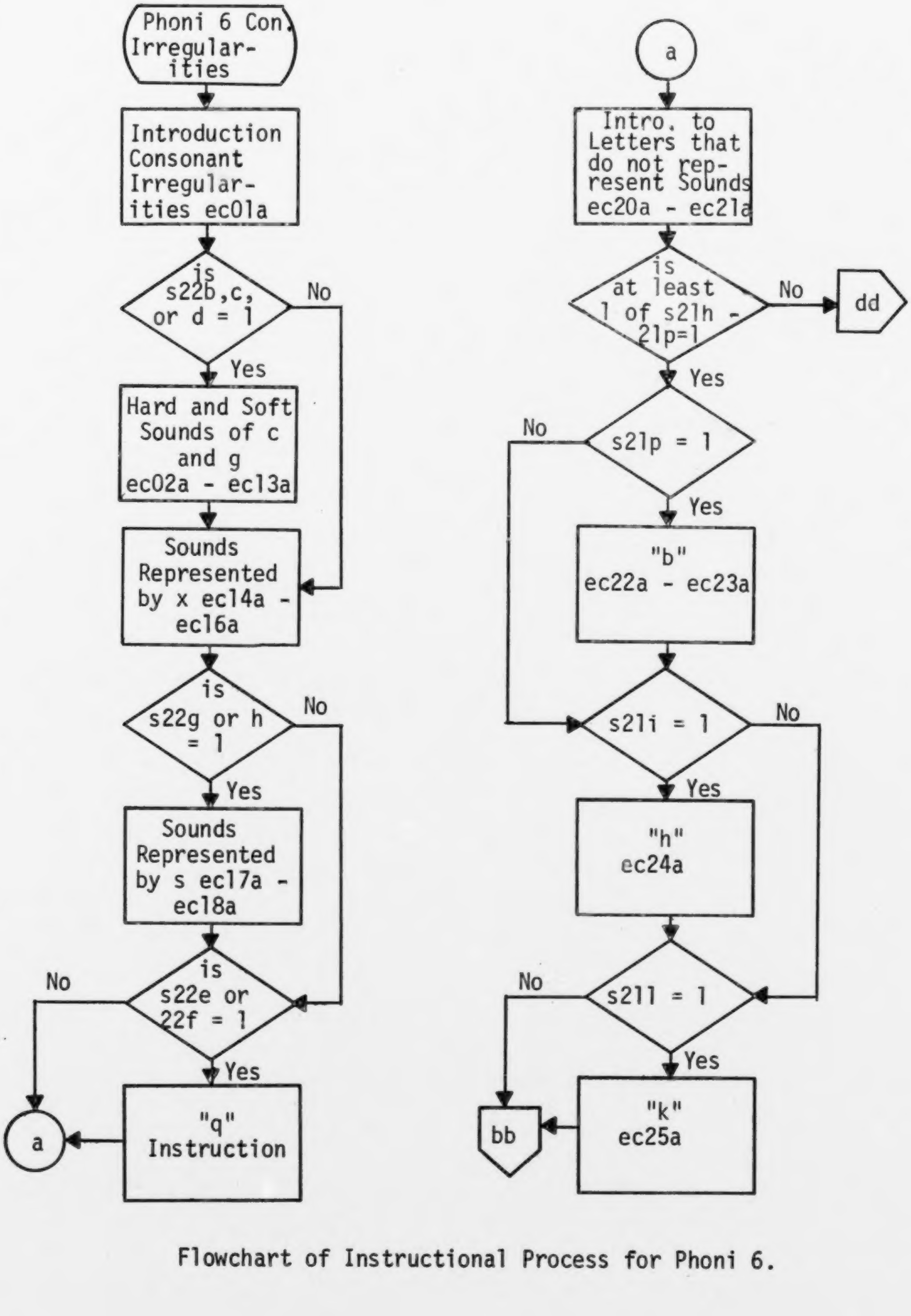
Flowchart of Instructional Process for Phoni 4 (continued).


cc
is 19p = 1
No
are 2 of s 20a,b,c,d, e=1
Yes
No
Introduction Long Vowel Sounds va01a - va06a
Single-Final Generalization va07a - va11a
Yes
is s20g = 1
No
Final e Generalization va12a - va19a
Yes
is s20f = 1
No
Adjacent Vowel Gen. va20a - va27a
is s20h = 1
No
Summary of Generalization vg28a
Opt. for Ill. Lesson
Yes
Illustrative Lesson vh01a - vh03a
No
Review Procedural Steps vh04a - vh06a
Yes
Opt.for Procedural Steps
No
a
a
Review vf01a - vf13a

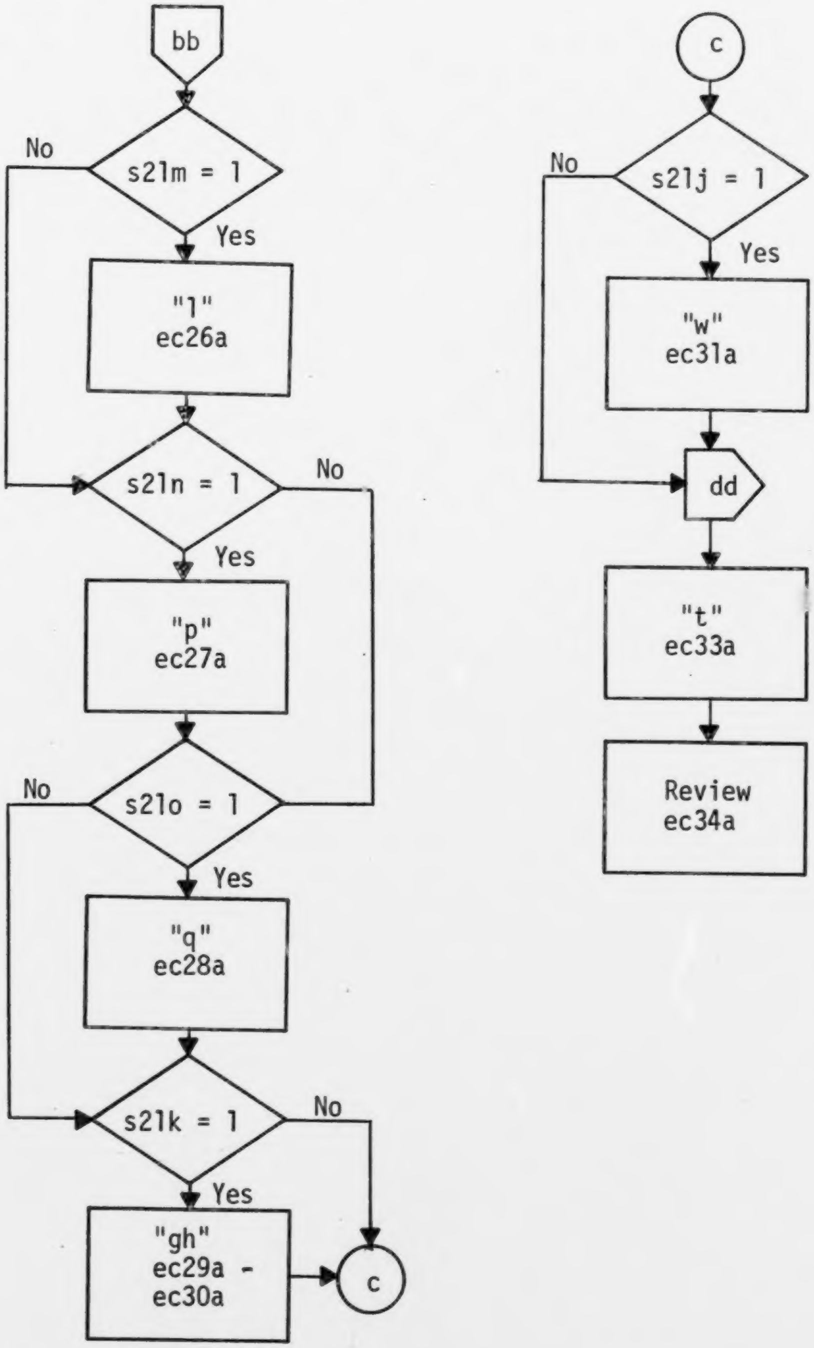
Flowchart of Instructional Process for Phoni 4 (continued).


Phoni 5
Vowel Dig. &
Diphthongs
is
s20i or
20j = 1
No
Yes
are
at
least 3 of
the switches
20m-20p,21a-
21f = 1
No
Yes
Introduction
to Vowel
Dighthongs &
Digraphs
wa01a - wa04a
Diphthongs
wa05a - we04a
Review and
Suggestions
for Teaching
we05a - we12a
is
s20k or
s20l =
1
No
are
at
least 3 of
the switches
20m-20p,21a-
21f = 1
No
Yes
Introduction
To Digraphs
wg01a - wg07a
is
s21g
= 1
Yes
No
b
Regular
Digraphs
wg08a - wg10a
a
Suggestions:
Teaching the ad-
jacent Vowel
Generalization
wg11a - wg13a
b
Other Somewhat
"Consistent"
Digraphs
wj01a - wjo7a
Hints for
Sounding Digraphs
wj08a - wj09a
Review
wm01a - wm08a

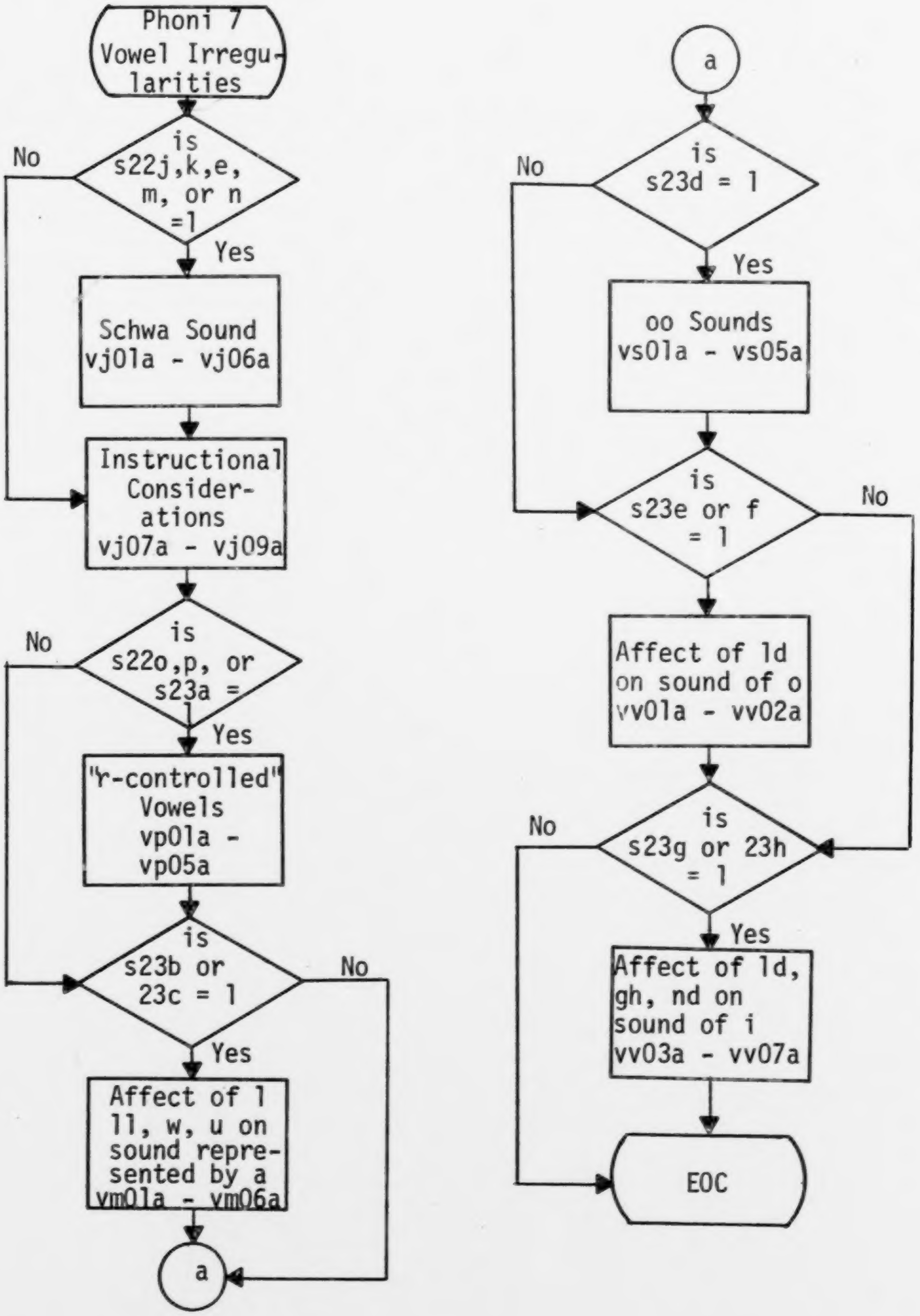
Flowchart of Instructional Process for Phoni 5.


Phoni 6 Con. Irregularities
Introduction Consonant Irregularities ec01a
is s22b,c, or d = 1
No
Yes
Hard and Soft Sounds of c and g ec02a - ec13a
Sounds Represented by x ec14a - ec16a
is s22g or h = 1
No
Yes
Sounds Represented by s ec17a - ec18a
is s22e or 22f = 1
No
Yes
"q" Instruction
a
a
Intro. to Letters that do not represent Sounds ec20a - ec21a
is at least 1 of s21h - 21p=1
No
dd
Yes
s21p = 1
No
Yes
"b" ec22a - ec23a
s21i = 1
No
Yes
"h" ec24a
s21l = 1
No
Yes
"k" ec25a
bb

Flowchart of Instructional Process for Phoni 6.

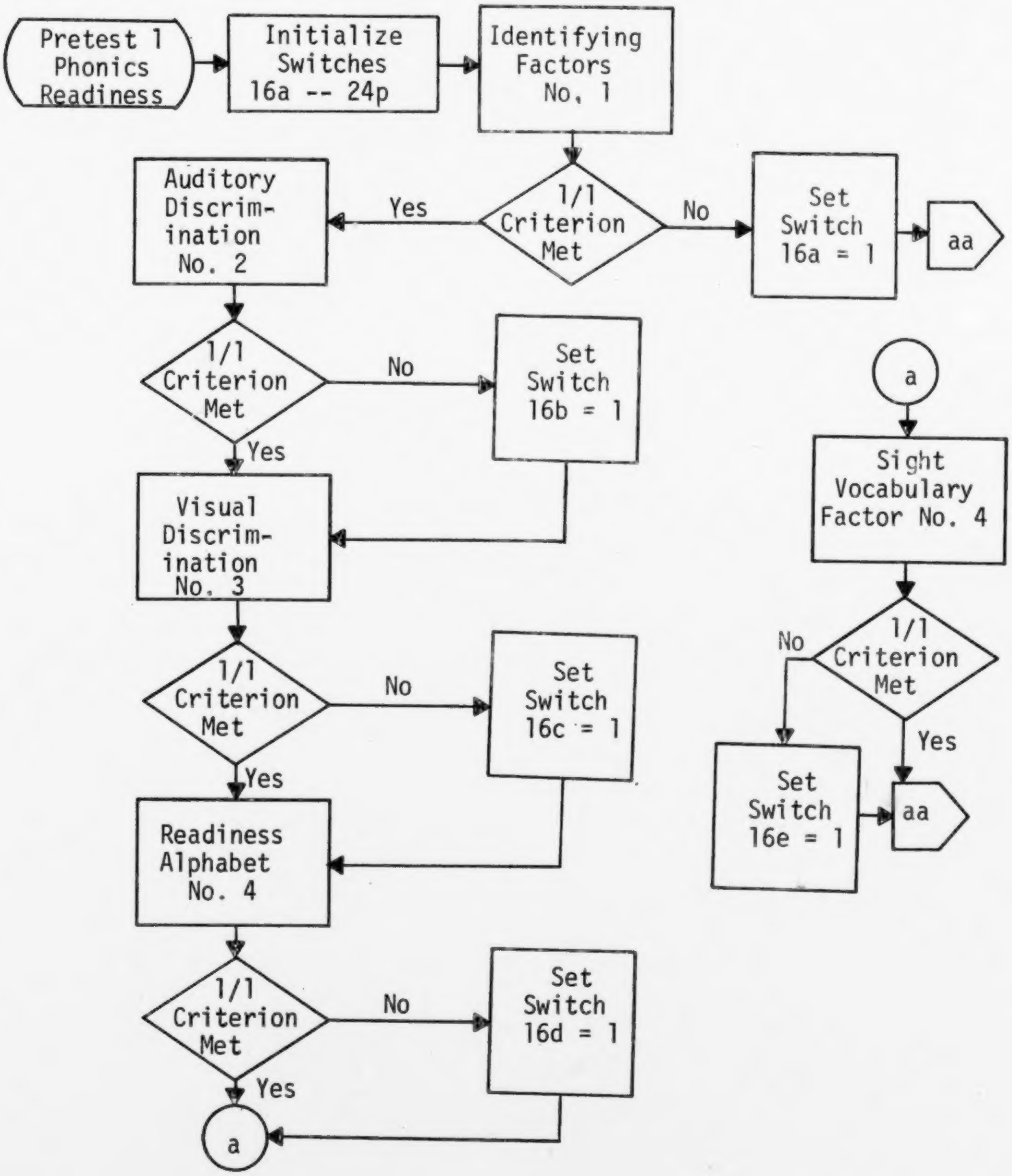

bb
s21m = 1
No
Yes
"l"
ec26a
s21n = 1
No
Yes
"p"
ec27a
s21o = 1
No
Yes
"q"
ec28a
s21k = 1
No
Yes
"gh"
ec29a -
ec30a
c
c
s21j = 1
No
Yes
"w"
ec31a
dd
"t"
ec33a
Review
ec34a

Flowchart of Instructional Process for Phoni 6 (continued).

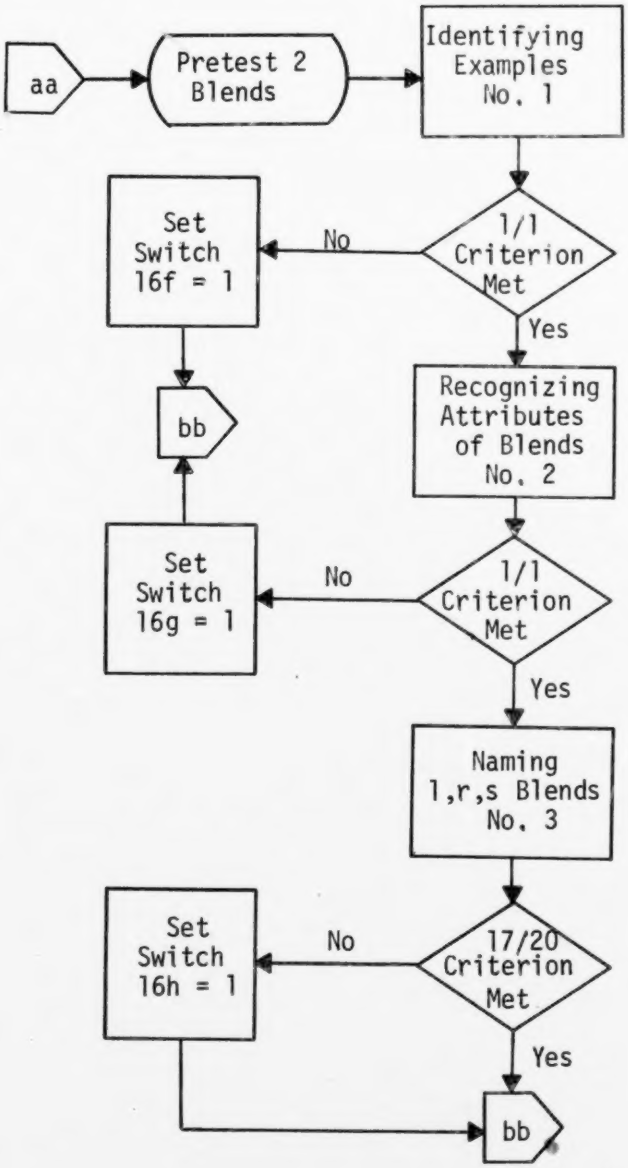

Phoni 7 Vowel Irregularities
is s22j,k,e, m, or n =1
No
Yes
Schwa Sound vj01a - vj06a
Instructional Considerations vj07a - vj09a
is s22o,p, or s23a =
No
Yes
"r-controlled" Vowels vp01a - vp05a
is s23b or 23c = 1
No
Yes
Affect of l ll, w, u on sound represented by a vm01a - vm06a
a
a
is s23d = 1
No
Yes
oo Sounds vs01a - vs05a
is s23e or f = 1
No
Affect of ld on sound of o vv01a - vv02a
is s23g or 23h = 1
No
Yes
Affect of ld, gh, nd on sound of i vv03a - vv07a
EOC

Flowchart of Instructional Process for Phoni 7.

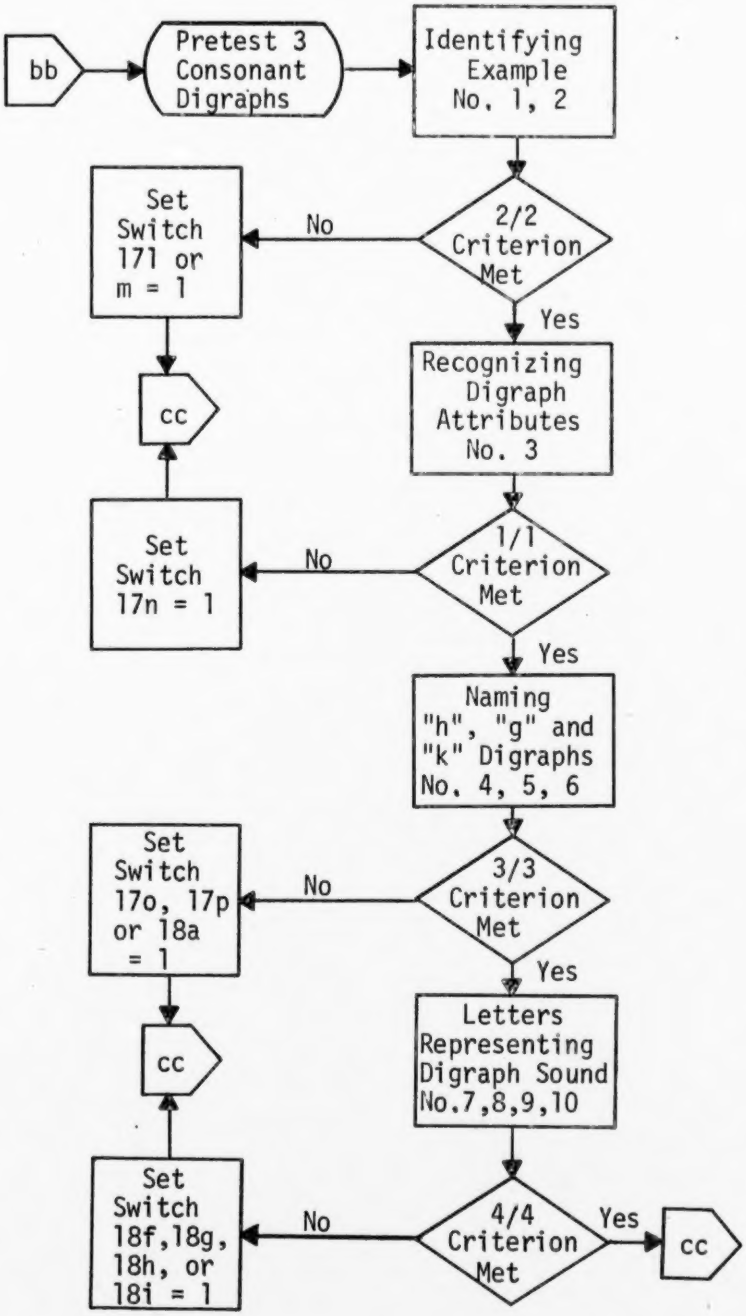
FLOWCHARTS OF PHONI 0 PRETESTS 1 - 10e


Pretest 1
Phonics
Readiness
Initialize
Switches
16a -- 24p
Identifying
Factors
No. 1
1/1
Criterion
Met
Yes
No
Set
Switch
16a = 1
aa
Auditory
Discrim-
ination
No. 2
1/1
Criterion
Met
No
Set
Switch
16b = 1
Yes
Visual
Discrim-
ination
No. 3
1/1
Criterion
Met
No
Set
Switch
16c = 1
Yes
Readiness
Alphabet
No. 4
1/1
Criterion
Met
No
Set
Switch
16d = 1
Yes
a
a
Sight
Vocabulary
Factor No. 4
1/1
Criterion
Met
No
Yes
Set
Switch
16e = 1
aa

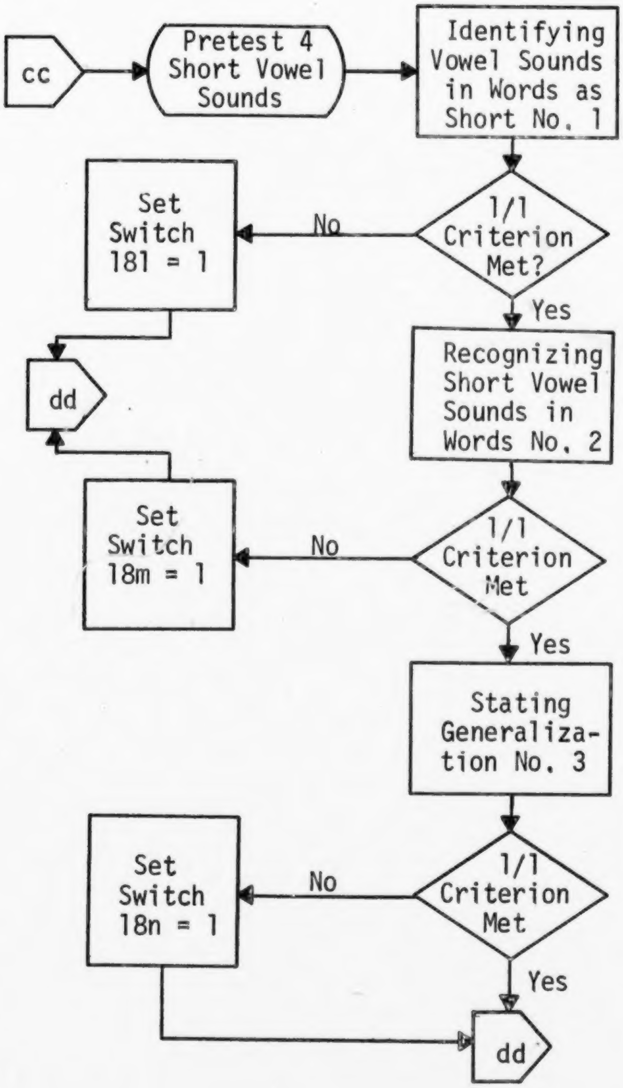
Flowchart of Phoni Pretest 1.


aa
Pretest 2 Blends
Identifying Examples No. 1
1/1 Criterion Met
No
Yes
Set Switch 16f = 1
bb
Recognizing Attributes of Blends No. 2
1/1 Criterion Met
No
Yes
Set Switch 16g = 1
Naming l,r,s Blends No. 3
17/20 Criterion Met
No
Yes
Set Switch 16h = 1
bb

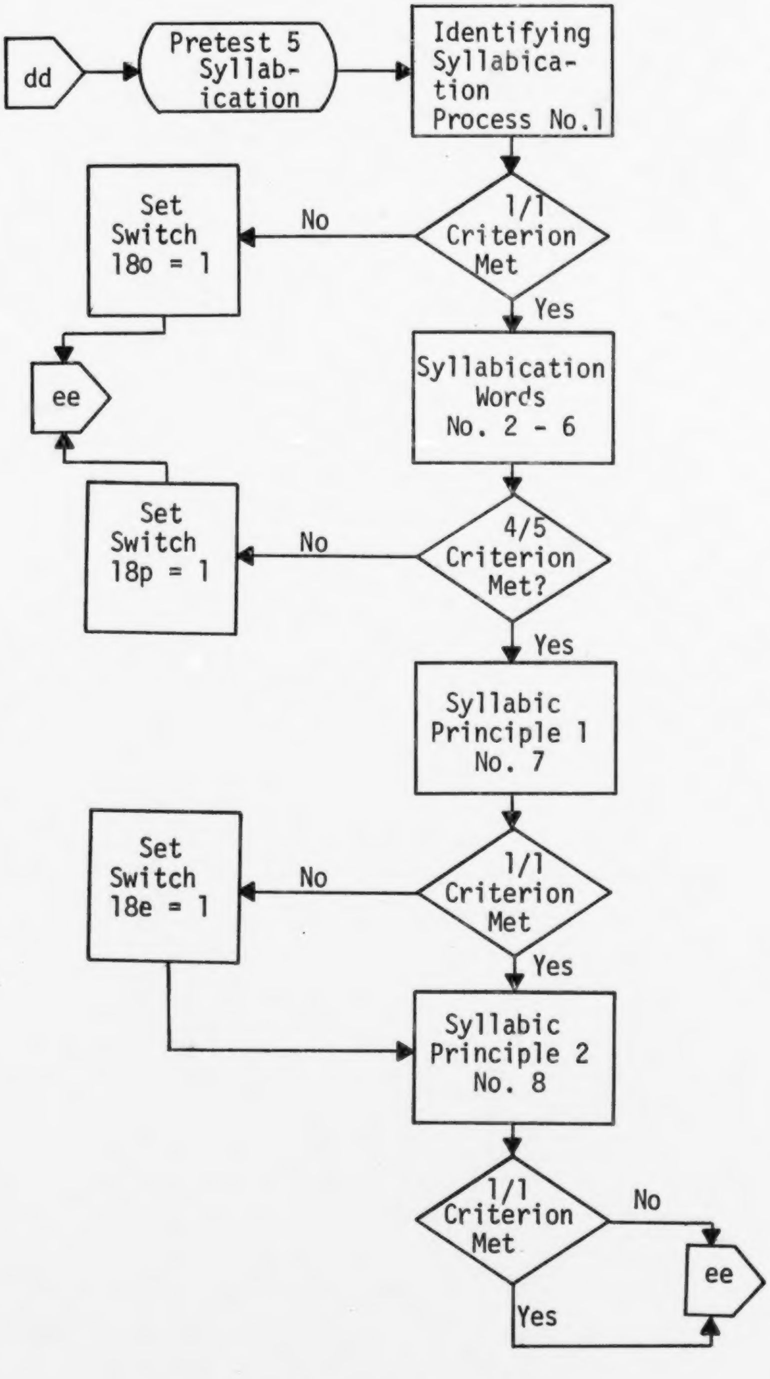
Flowchart of Phoni Pretest 2.


bb
Pretest 3 Consonant Digraphs
Identifying Example No. 1, 2
2/2 Criterion Met
No
Yes
Set Switch 17l or m = 1
cc
Recognizing Digraph Attributes No. 3
1/1 Criterion Met
No
Yes
Set Switch 17n = 1
Naming "h", "g" and "k" Digraphs No. 4, 5, 6
3/3 Criterion Met
No
Yes
Set Switch 17o, 17p or 18a = 1
cc
Letters Representing Digraph Sound No.7,8,9,10
4/4 Criterion Met
No
Yes
cc
Set Switch 18f,18g, 18h, or 18i = 1
cc

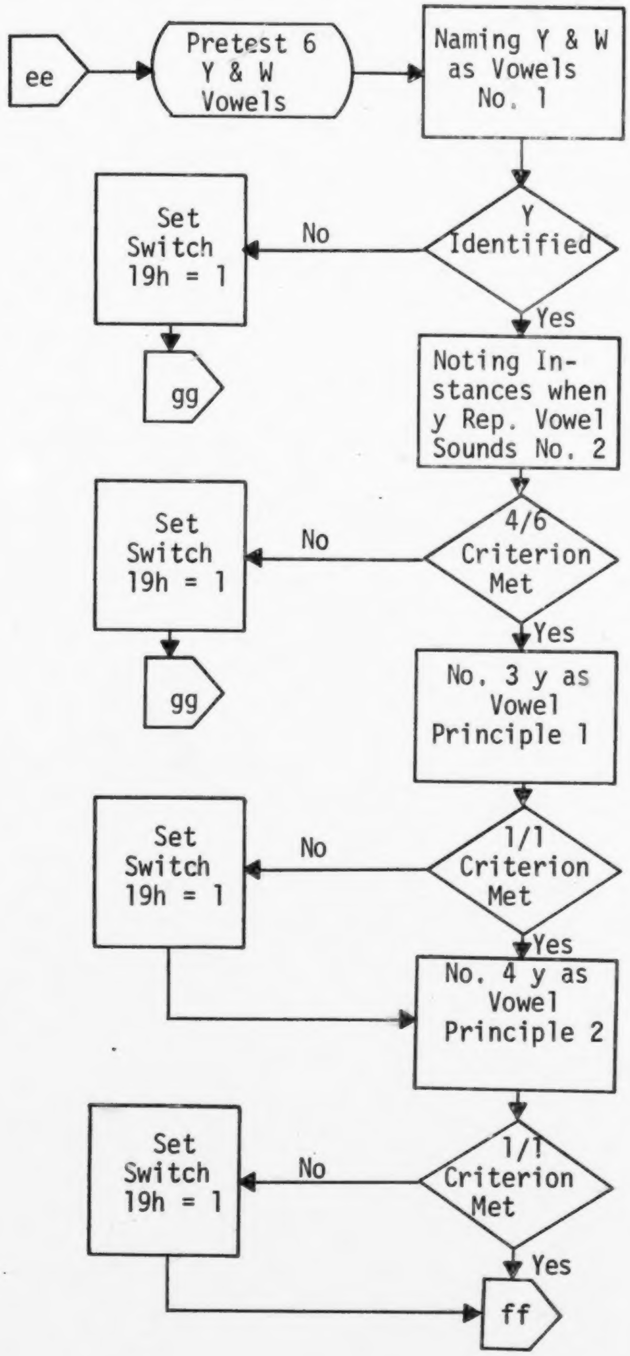
Flowchart of Phoni Pretest 3.


cc
Pretest 4 Short Vowel Sounds
Identifying Vowel Sounds in Words as Short No. 1
1/1 Criterion Met?
No
Set Switch 18l = 1
Yes
dd
Recognizing Short Vowel Sounds in Words No. 2
1/1 Criterion Met
No
Set Switch 18m = 1
Yes
Stating Generaliza-tion No. 3
1/1 Criterion Met
No
Set Switch 18n = 1
Yes
dd

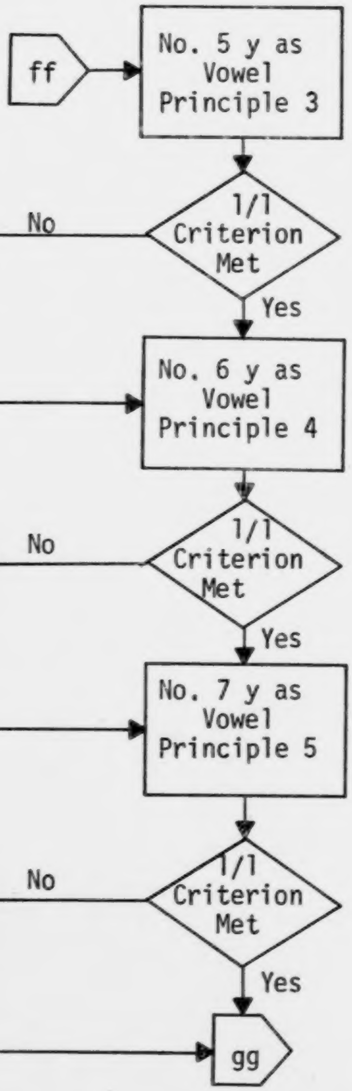
Flowchart of Phoni Pretest 4.


dd
Pretest 5 Syllab-ication
Identifying Syllabica-tion Process No.1
1/1 Criterion Met
No
Yes
Set Switch 18o = 1
ee
Syllabication Words No. 2 - 6
4/5 Criterion Met?
No
Yes
Set Switch 18p = 1
Syllabic Principle 1 No. 7
1/1 Criterion Met
No
Yes
Set Switch 18e = 1
Syllabic Principle 2 No. 8
1/1 Criterion Met
No
Yes
ee

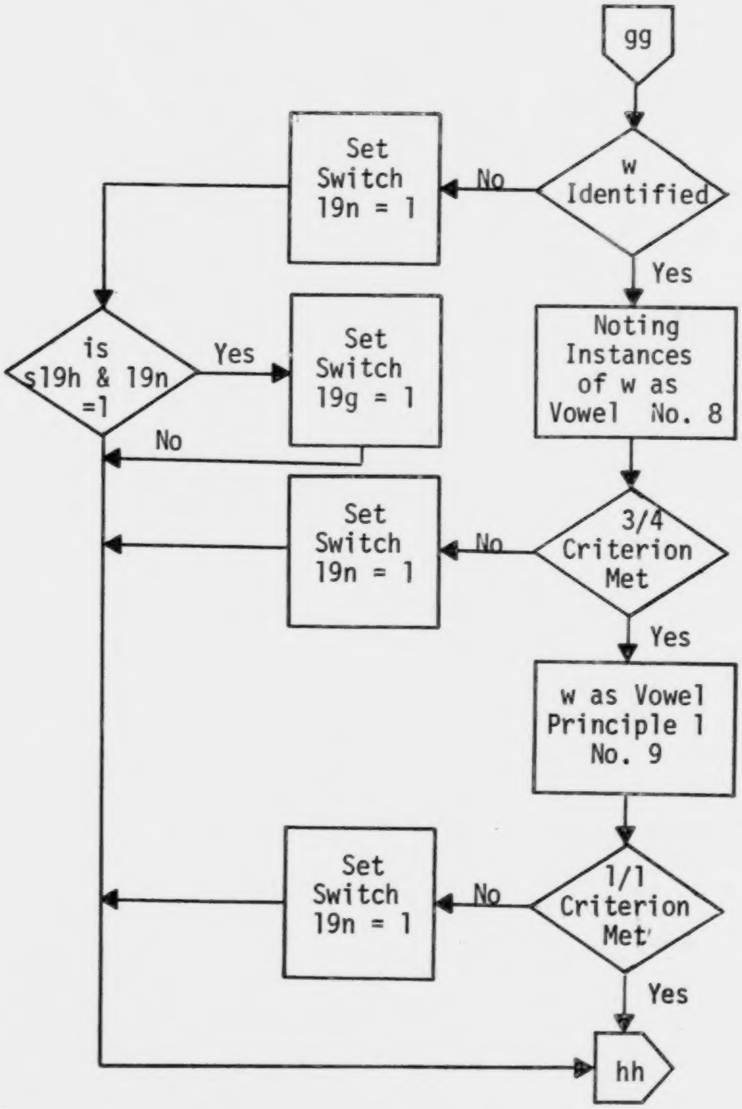
Flowchart of Phoni Pretest 5.


ee
Pretest 6 Y & W Vowels
Naming Y & W as Vowels No. 1
Y Identified
No
Yes
Set Switch 19h = 1
gg
Noting Instances when y Rep. Vowel Sounds No. 2
4/6 Criterion Met
No
Yes
Set Switch 19h = 1
gg
No. 3 y as Vowel Principle 1
1/1 Criterion Met
No
Yes
Set Switch 19h = 1
No. 4 y as Vowel Principle 2
1/1 Criterion Met
No
Yes
Set Switch 19h = 1
ff

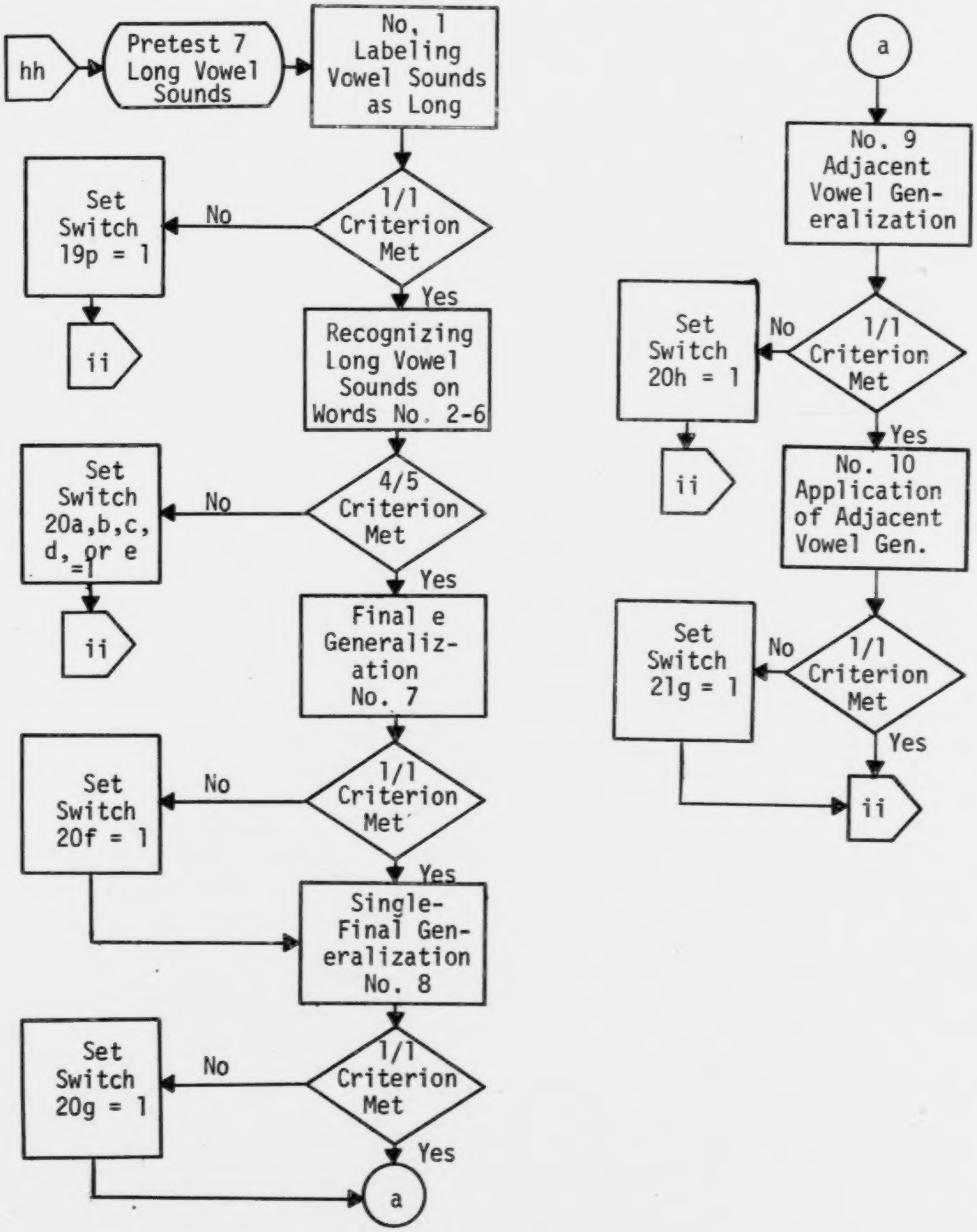
Flowchart of Phoni Pretest 6.


ff
No. 5 y as Vowel Principle 3
1/1 Criterion Met
No
Set Switch 19h = 1
Yes
No. 6 y as Vowel Principle 4
1/1 Criterion Met
No
Set Switch 19h = 1
Yes
No. 7 y as Vowel Principle 5
1/1 Criterion Met
No
Set Switch 19h = 1
Yes
gg

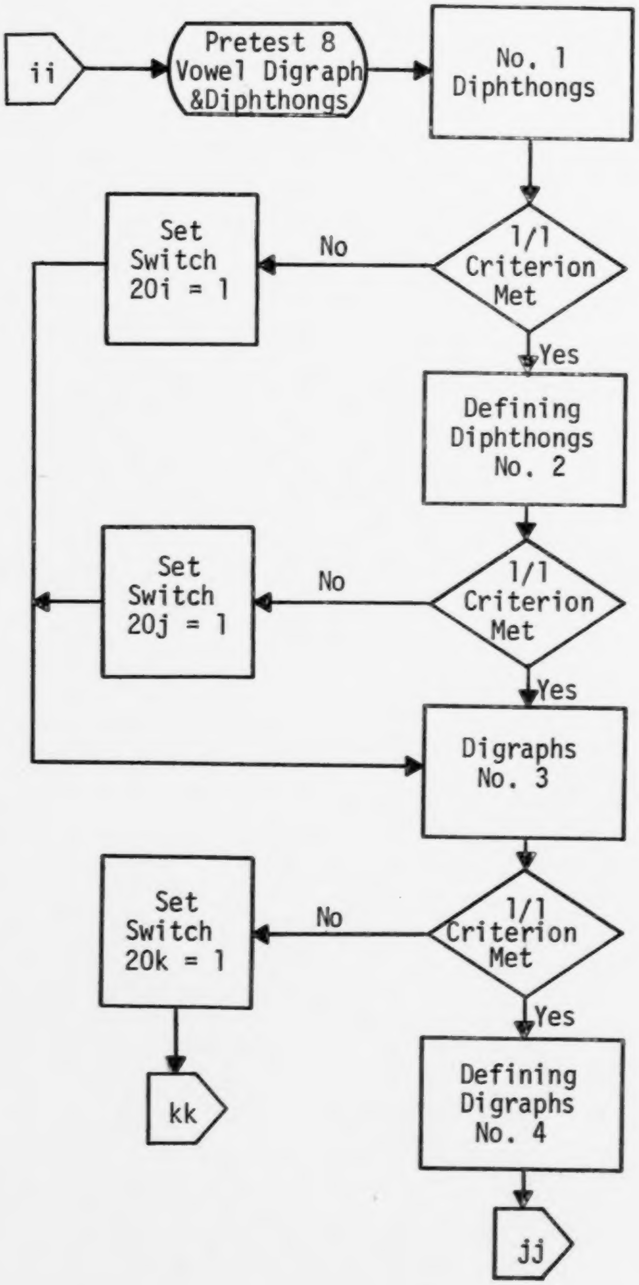
Flowchart of Phoni Pretest 6 (continued).


gg
w Identified
No
Set Switch 19n = 1
Yes
Noting Instances of w as Vowel No. 8
is s19h & 19n =1
Yes
Set Switch 19g = 1
No
3/4 Criterion Met
No
Set Switch 19n = 1
Yes
w as Vowel Principle 1 No. 9
1/1 Criterion Met
No
Set Switch 19n = 1
Yes
hh

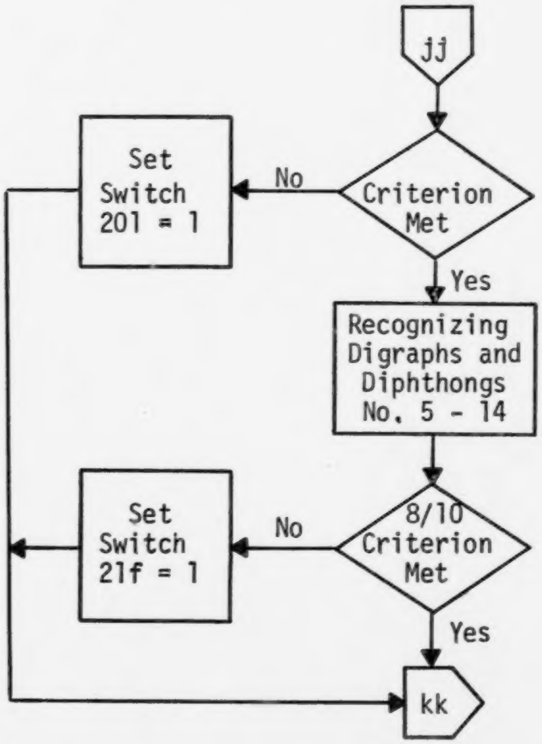
Flowchart of Phoni Pretest 6 (continued).


hh
Pretest 7 Long Vowel Sounds
No. 1 Labeling Vowel Sounds as Long
1/1 Criterion Met
No
Set Switch 19p = 1
ii
Yes
Recognizing Long Vowel Sounds on Words No. 2-6
4/5 Criterion Met
No
Set Switch 20a,b,c, d, or e =1
ii
Yes
Final e Generalization No. 7
1/1 Criterion Met
No
Set Switch 20f = 1
Yes
Single-Final Generalization No. 8
1/1 Criterion Met
No
Set Switch 20g = 1
Yes
a
a
No. 9 Adjacent Vowel Generalization
1/1 Criterion Met
No
Set Switch 20h = 1
ii
Yes
No. 10 Application of Adjacent Vowel Gen.
1/1 Criterion Met
No
Set Switch 21g = 1
Yes
ii

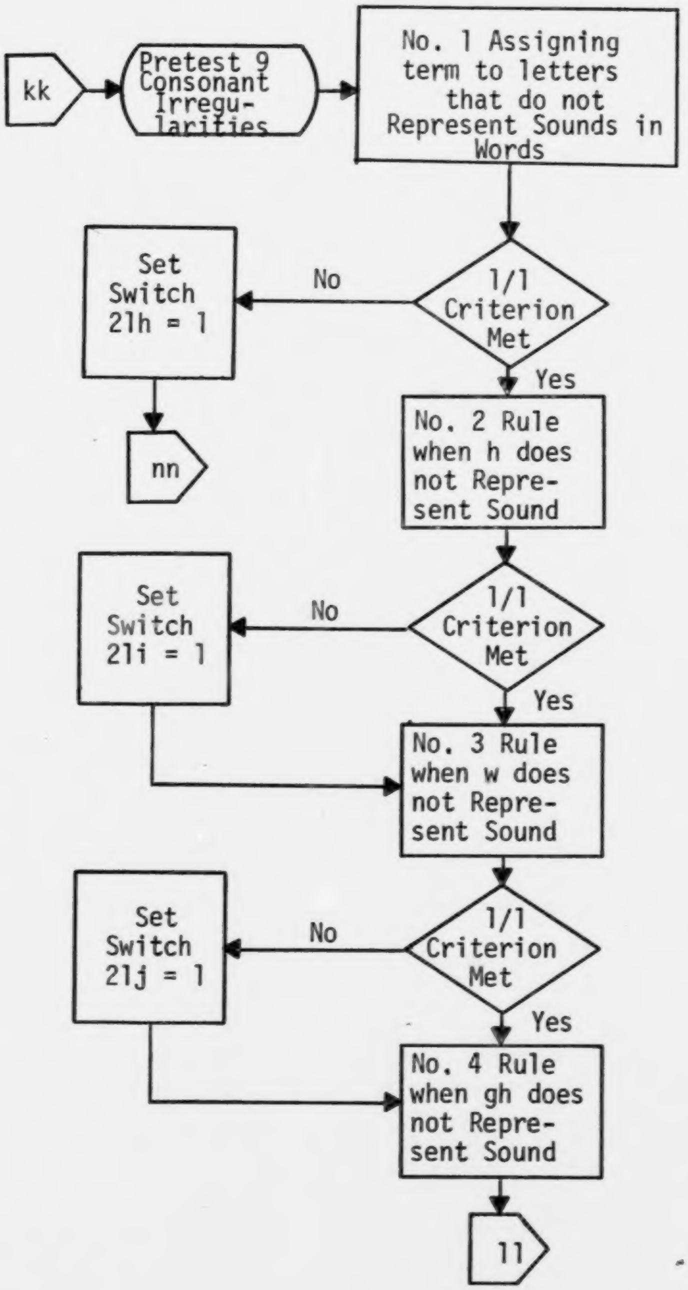
Flowchart of Phoni Pretest 7.


ii
Pretest 8 Vowel Digraph &Diphthongs
No. 1 Diphthongs
1/1 Criterion Met
No
Set Switch 20i = 1
Yes
Defining Diphthongs No. 2
1/1 Criterion Met
No
Set Switch 20j = 1
Yes
Digraphs No. 3
1/1 Criterion Met
No
Set Switch 20k = 1
kk
Yes
Defining Digraphs No. 4
jj

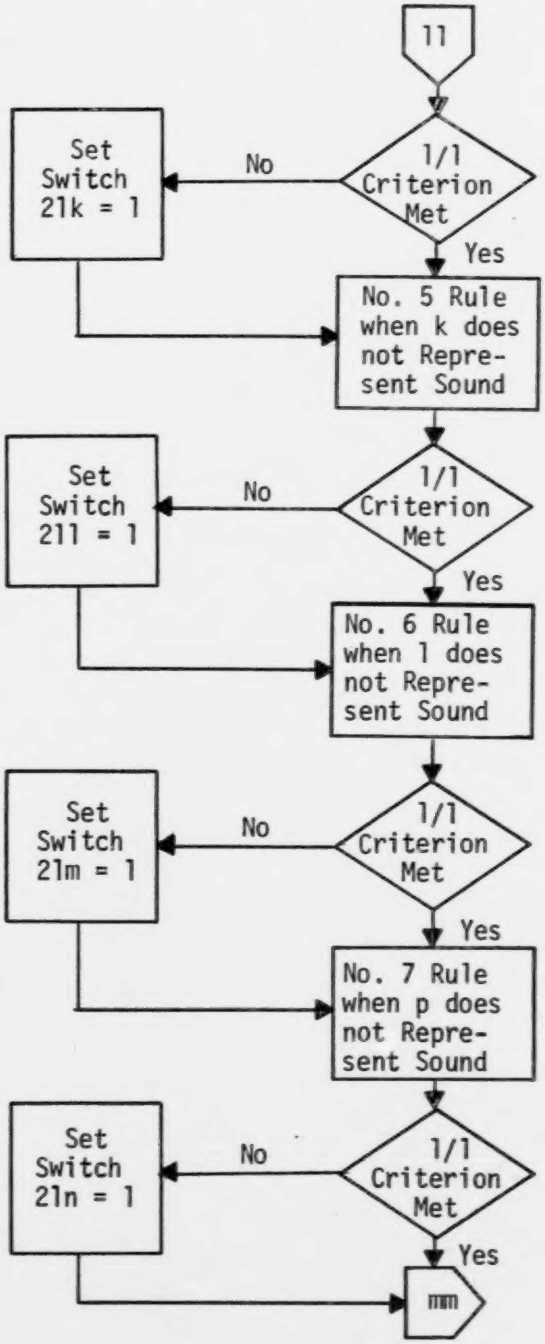
Flowchart of Phoni Pretest 8.


jj
Criterion Met
No
Yes
Set Switch 20l = 1
Recognizing Digraphs and Diphthongs No. 5 - 14
8/10 Criterion Met
No
Yes
Set Switch 21f = 1
kk

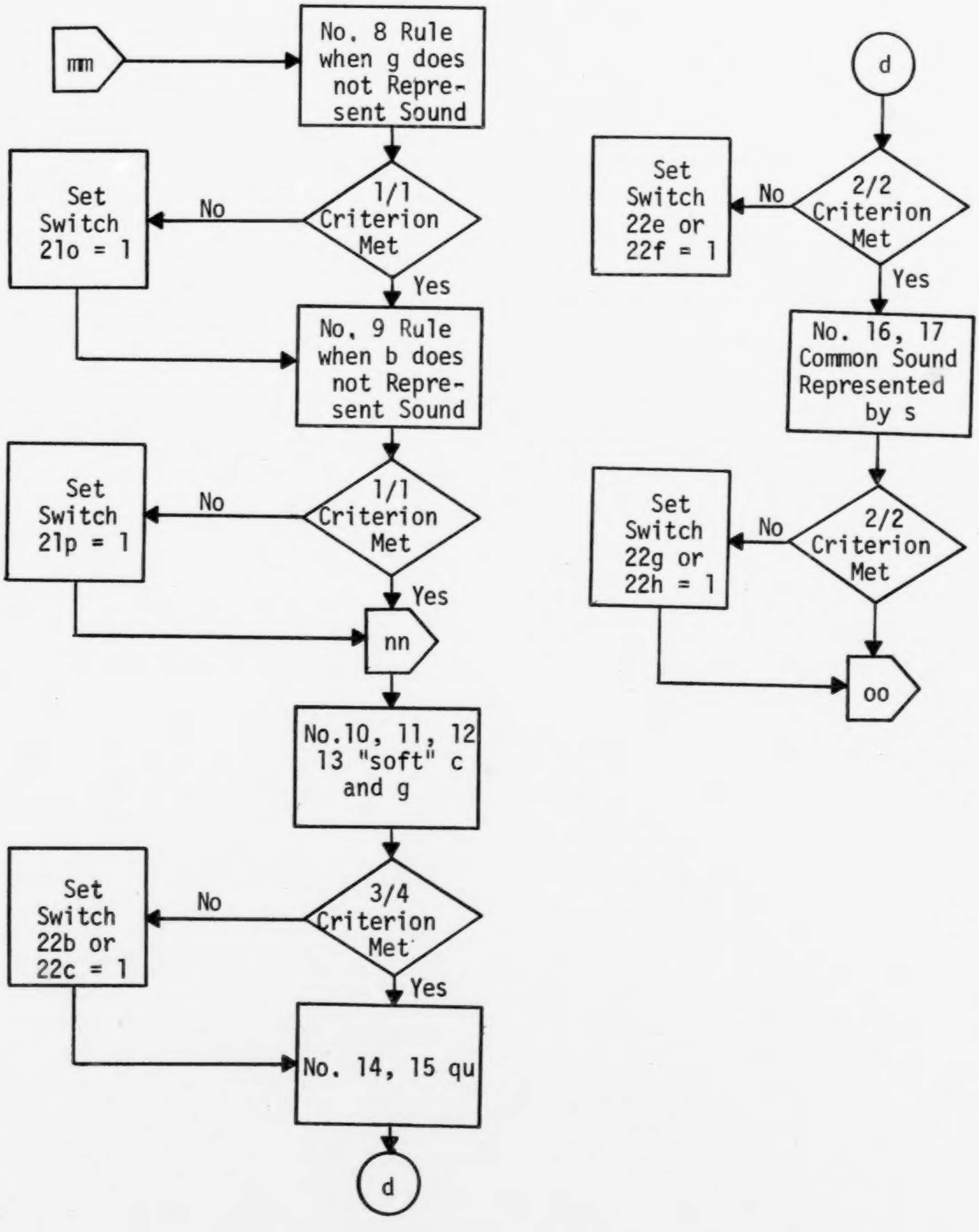
Flowchart of Phoni Pretest 8 (continued).


kk
Pretest 9 Consonant Irregularities
No. 1 Assigning term to letters that do not Represent Sounds in Words
1/1 Criterion Met
No
Yes
Set Switch 21h = 1
nn
No. 2 Rule when h does not Represent Sound
1/1 Criterion Met
No
Yes
Set Switch 21i = 1
No. 3 Rule when w does not Represent Sound
1/1 Criterion Met
No
Yes
Set Switch 21j = 1
No. 4 Rule when gh does not Represent Sound
11

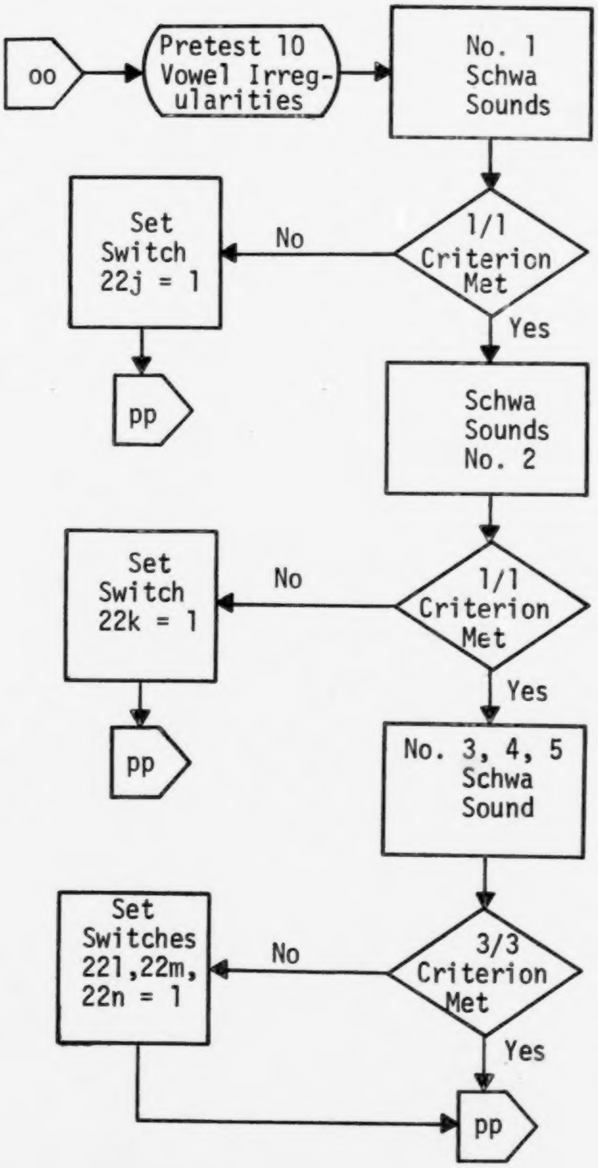
Flowchart of Phoni Pretest 9.


11
1/1 Criterion Met
No
Set Switch 21k = 1
Yes
No. 5 Rule when k does not Represent Sound
1/1 Criterion Met
No
Set Switch 21l = 1
Yes
No. 6 Rule when l does not Represent Sound
1/1 Criterion Met
No
Set Switch 21m = 1
Yes
No. 7 Rule when p does not Represent Sound
1/1 Criterion Met
No
Set Switch 21n = 1
Yes
mm

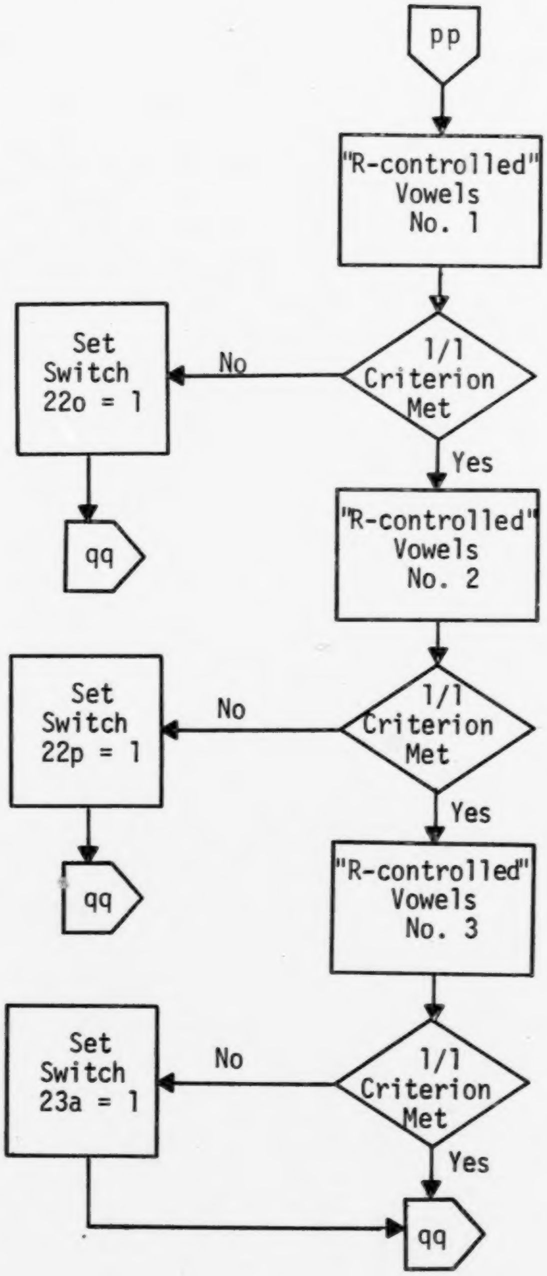
Flowchart of Phoni Pretest 9 (continued).


mm
No. 8 Rule when g does not Represent Sound
1/1 Criterion Met
No
Set Switch 21o = 1
Yes
No. 9 Rule when b does not Represent Sound
1/1 Criterion Met
No
Set Switch 21p = 1
Yes
nn
No.10, 11, 12 13 "soft" c and g
3/4 Criterion Met
No
Set Switch 22b or 22c = 1
Yes
No. 14, 15 qu
d
d
2/2 Criterion Met
No
Set Switch 22e or 22f = 1
Yes
No. 16, 17 Common Sound Represented by s
2/2 Criterion Met
No
Set Switch 22g or 22h = 1
oo

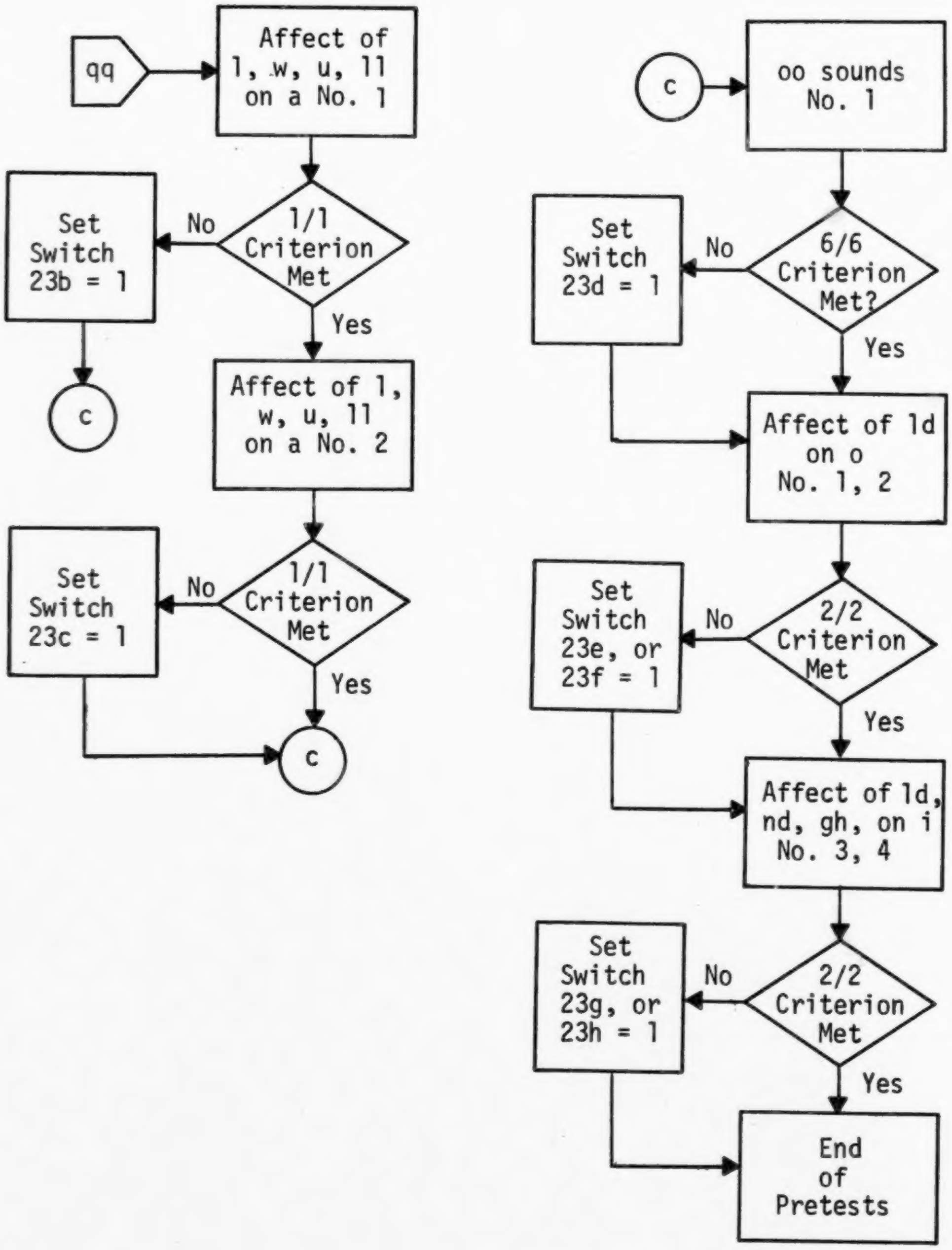
Flowchart of Phoni Pretest 9 (continued).


oo
Pretest 10 Vowel Irregularities
No. 1 Schwa Sounds
1/1 Criterion Met
No
Set Switch 22j = 1
pp
Yes
Schwa Sounds No. 2
1/1 Criterion Met
No
Set Switch 22k = 1
pp
Yes
No. 3, 4, 5 Schwa Sound
3/3 Criterion Met
No
Set Switches 22l,22m, 22n = 1
Yes
pp

Flowchart of Phoni Pretest 10a.


pp
"R-controlled" Vowels No. 1
1/1 Criterion Met
No
Set Switch 22o = 1
qq
Yes
"R-controlled" Vowels No. 2
1/1 Criterion Met
No
Set Switch 22p = 1
qq
Yes
"R-controlled" Vowels No. 3
1/1 Criterion Met
No
Set Switch 23a = 1
Yes
qq
qq

Flowchart of Phoni Pretest 10b.


qq
Affect of l, w, u, ll on a No. 1
1/1 Criterion Met
No
Yes
Set Switch 23b = 1
c
Affect of l, w, u, ll on a No. 2
1/1 Criterion Met
No
Yes
Set Switch 23c = 1
c
c
oo sounds No. 1
6/6 Criterion Met?
No
Yes
Set Switch 23d = 1
Affect of ld on o No. 1, 2
2/2 Criterion Met
No
Yes
Set Switch 23e, or 23f = 1
Affect of ld, nd, gh, on i No. 3, 4
2/2 Criterion Met
No
Yes
Set Switch 23g, or 23h = 1
End of Pretests

Flowchart of Phoni Pretest 10c, 10d, 10e.

APPENDIX F

VALIDATION PLAN FORMS

Pretest	EP Identifier	Concept Area	Number of Students Presented Question	Percent	Number of Correct Responses to EP	Percent	Number Branched Over Instruc.

Fig. 4. Form A for reporting pretest performance by question.

ID Number	Number Questions Presented	Number Correct Responses	Total Points	Weighted Score	Total Pretest Time

Fig. 5. Form B for reporting precourse performance by individual student.

Mean Correct Responses	Mean Weighted Score	Range	Standard Deviation

Fig. 6. Form C for reporting pretest summary data.

Segment	EP Identifier	Number Presented EP	Number of Correct First Responses	Number of Incorrect Last Responses	Difficulty Level	Mean Number of Responses to EP	Number of Response Latencies > 1 Min.	Response Mode

Fig. 7. Form D for reporting incourse item analysis data.

Percent Correct Responses	Percent of Validation Group

Fig. 8. Form E for reporting materials validation data.

Posttest Question	Objectives Measured	Number of Students Meeting Criterion	Percent

Fig. 9. Form F for reporting item criterion validation data.

Student ID Number	Percent Pretest	Percent Posttest	Cumulative Time On-Line

Fig. 10. Form G for reporting summary data.

APPENDIX G

PRE- AND POSTTESTS AND
WEIGHTING SCHEME FOR SCORING

PHONI PRETESTS

PRETEST 1

1. Before a child can profit from instruction in phonic analysis, he must have acquired certain skills and knowledges and developed certain abilities. Look at the list of skills, abilities and knowledges shown on the image. Type the number of each statement that is one of the four prerequisites for phonic analysis:

[1] [13] [15] [19]

(Criterion 3/4; .5 points for each correct answer)

1. auditory discrimination between speech sounds
2. is skillful in using the context for word meaning
3. has a mental age of at least five years
4. has good vision
5. can speak and understand standard English
6. is familiar with many common objects
7. has adequate motor coordination
8. has developed in psycholinguistic abilities
9. is skillful in printing letters
10. has a rich and wide experiential background
11. demonstrates good classroom decorum
12. has a wide reading vocabulary
13. can recognize and discriminate visually between printed letters
14. knows the "basic sight" words
15. can recognize some whole words in written form
16. knows common word patterns in sentences
17. knows basic principles of syllabication
18. knows numbers from 1 - 10

19. knows letters of alphabet by name and shape

20. is articulate and fluent in speech expression

2. To what does auditory discrimination for phonics instruction refer?

   [Ability to distinguish whole words in spoken form]

   [Ability to distinguish between sounds in a word] [1 point]

   [Ability to hear all sounds in the spoken language]

3. To what does visual discrimination for phonics instruction refer?

   [Ability to see similarities and differences in printed letters]

   [Ability to recognize printed letters] [1 point]

   [Ability to perceive the whole word as a unit]

4. Why does a child need to know the letters of the alphabet by name and shape for phonics instruction?

   [To help in identifying correct sounds]

   [To see that each letter stands for a particular sound] [1 point]

   [To facilitate communication in the teaching-learning process]

5. Why is the child's ability to recognize some whole words in printed form important for phonics instruction?

   [To provide reference points for introducing letter-sound relationships]

   [To help the child understand the concept of a word] [1 point]

   [To facilitate pupil-teacher communication]

[Total Points = 6]

PRETEST 2

1. The sk in skid, the cr in cream, and the fl in floor are examples of:

   [✓ consonant blends] [consonant digraphs] [consonant plosives]

   [1 Point]

2. Look at the four statements on the image. Type the number of the statement which best describes a consonant blend:

   [a combination of consonant letters which stand for a single, distinct sound]

   [✓ a consonant letter combination in which the individual consonant sounds are distinguishable in the resultant sound]

   [a consonant letter combination which represents a sound unlike either of the single consonant sounds involved]

   [two consonant letters which are sounded as one letter]

   [1 Point]

3. At the beginning of each row below is one of the letters that is common to a group of consonant blends. Type all consonant blends with each "blender" on the respective row. Enter when you finish each row:

   l [bl, cl, fl, gl, pl, sl] 5/6 = 1 point

   r [br, cr, dr, fr, gr, pr, tr] 6/7 = 1 point

   s [sc, sk, sm, sn, sp, st, sw] 6/7 = 1 point

   [3 Points]

[Total Points = 5]

PRETEST 3

1. Type the consonant combination in the word phonograph other than gr:

   ph

   [No Points]

2. You have indicated that the letters ph in the word phonograph are a consonant combination. Type the name of this combination if you know it. Type the words "don't know" if you do not know its name:

   consonant digraph

   [1 Point]

3. Of the following statements, choose the one that most accurately describes a consonant digraph:

   [two consonant letters which are sounded together]

   [a combination of single consonant letters whose sounds merge to form a single sound]

   [two consonant letters, representing a single, distinct sound that may be unlike either single letter sound]

   [1 Point]

4. Six digraphs are formed with the letter "h." Type these six "h" digraphs:

   gh ph sh wh th ch

5. One digraph is formed with the letter g; type this digraph:

   ng

6. Type the end digraph that is formed with the letter k:

   ck

   [8/8 = 1 Point]

7. Next to each digraph, type the letter or letter combination that represents the digraph sound(s) as illustrated in the key words:

ch	chaos	(k)	wh	where	(hw) or (w)
ph	phone	(f)			
gh	rough	(f)			

[3/4 = 1 point]

[Total Points = 4]

PRETEST 4

1. What is the same about the vowel sounds in these words?

cupdap dollup fedmip ilslep

[long vowel sound] [medial vowel sound]

[short vowel sound] [schwa sound]

[1 Point]

2. Put on your earphones to listen to some words containing vowel sounds. The words will be given in pairs. Type one of the words from the pair which could serve as a key word for the short vowel sound: a, e, i, o, u. Type the word under the vowel letter whose short sound is heard:

AUDIO MESSAGE

[5/5 = 1 Point]

3. Complete these phrases to construct the generalization for the vowel sounds in cat and imp:

In a word or syllable in which there is {a vowel / a single vowel / only one vowel}

which {is in the medial or initial / is in the middle or beginning / is not in the ending} position of the word or syllable, The vowel sound is short.

[3 Points]

[Total Points = 5]

PRETEST 5

1. Look closely at the action below:

gerrymander	ger	ry	man	der
haberdasher	hab	er	dash	er

What do we call the process illustrated? syllabication

2. Retype each of the words in the space provided. Indicate the syllabic division by typing a slash after every syllable except the last one.

Example:	commiserate	com/mis/er/ate
	wadpun	wad/pun
	curbo	cur/bo
	daddop	dad/dop
	bomel	bo/mel
	siget	si/get

3. Complete these statements so that the syllabic principle observed in wadpun, curbo and daddop is formed.

When two consonants are between two vowels the first consonant ends the first syllable and the second consonant begins the second syllable. [2 Points]

4. Complete this statement so that the syllabic principle observed in bomel and siget is formed.

A word having two vowels which are separated by a single consonant usually divides after the first vowel. [2 Points]

[Total Points = 4]

PRETEST 6

1. There are two consonant letters that represent vowel sounds in certain situations; type these two letters: y w

[No Points]

2. Type the number of each word below in which y represents a vowel sound:

(1.) lyte 2. yam (3.) eye (4.) gyp

(5.) heavy (6.) cry 7. your (8.) syzgy

[No Points]

3. You identified y as representing a vowel sound in these words: gyp, heavy, cry, syzgy. Type the reason why:

no other vowel in word or syllable

[1 Point]

4. You identified y as representing a vowel sound in this word: eye. Type the reason why: y immediately follows a vowel in the same syllable.

[No Points]

5. What vowel sound does y stand for in this nonsense word?

skregy long ē [1 Point]

6. Type the vowel sound that y represents in this nonsense word.

myp short ĭ [1 Point]

7. What vowel sound does y stand for in this nonsense word?

sry long ī [1 Point]

8. Type the number of each word in which w stands for a vowel sound:

1. work (2.) cower 3. wisk (4.) drawl 5. wait
(6.) hew (7.) awful [No Points]

9. Why does w represent a vowel sound in the words cower, drawl hew and awful?

it immediately follows a vowel on the same syllable.

[1 Point]

[Total Points = 5]

PRETEST 7

1. What is the same about the vowel sounds in these words?

   soak mete mail alo eel

   [blended vowel sound] [long vowel sound]

   [double vowel sound] [short vowel sound]

   [1 Point]

2. In each group of words, you will hear one word in which the long vowel sound of one of the vowels is heard. Type the name of the vowel letter whose long sound is heard.

   1. map, signet, corn, beat
   2. men, whip, lay, blouse
   3. useless, ostrich, bit, wham
   4. an, dye, risk, wet
   5. top, oat, wept, slam

   [5/5 = 1 Point]

Complete these phrases so that they comprise the generalization for the vowel sounds in the words on the image.

hate
mope
use
eve
bite

hero
nitro
hi
be

meet
aid
ray
bead

3. When there are two vowels one of which is final e and they are separated by a consonant, the vowel sound heard is the long sound of first; and the final e is "silent".

   [5 Points]

4. When there is a single vowel in a word or syllable and it comes at the end of the word or syllable, the vowel sound is long.

   [3 Points]

5. In a syllable which contains adjacent vowels the vowel sound heard is usually the long sound of first . The second is "silent" .

[3 Points]

6. Complete this modified generalization of the adjacent vowel generalization:

When ai , oa , ay , ee , oe , ea are in the same syllable, the long sound of the first vowel is heard.

(Choose from these combinations: ai, ea, ie, oa, ue, au, ee, oe, ui, ay, ei, oi, uy, aw, eu, oo, ey, ue, ew, ou)

[Total Points = 14]

PRETEST 8

1. What do we call the underlined vowel letter combinations in these words?

toil loud crowd

[diphthongs] [digraphs] [glides] [schwas]

[1 Point]

2. Which statement most accurately describes a diphthong?

[two short vowel sounds blended] [two vowels that stand for a long vowel sound]

[two vowels-single blended sound] [two vowels - one vowel sound]

[1 Point]

3. What do we call the underlined vowel letter combinations in these words?

deed beat laid height

[double vowels] [digraphs] [consonantal vowels] [long vowels]

[1 Point]

4. Which statement most accurately describes a vowel digraph?

[two vowels that stand for the long sound of the first]

[two vowels that stand for one vowel sound]

[two vowels, long sound of second vowel]

[1 Point]

5. The underlined vowel letter combinations are either diphthongs or digraphs. Next to each word, type "1" for diphthong or "2" for digraph:

boil (1)

deed (2)

boat (2)

boy (1)

laid (2)

height (2)

cow (1)

snow (1) or (2)

great (2)

house (1)

[10/10 = 2 Points]

[Total Points = 6]

PRETEST 9

(Note: Each correct answer from 2 - 9 equals .5 points)

1. What is the same about the underlined consonant letters in these words?

   fummer   gnak   rhetun   wruph   fumb

   [forms consonant combination]   [controls vowel sound]

   [begins syllable]   [silent consonant]   [voiced consonant]

   [No Points]

2. The following statements are situations in which a certain consonant letter is silent. Read the statements then type the consonant from those below to which the statements refer:

   (h) is usually "silent" when it: 1) follows or precedes a vowel sound; 2) follows the letter r, g, or k.

   c   f   h   s   m   l   p

3. Which consonant letter, when appended to the beginning of the following words would not alter the pronunciation? (w)

   ring   raps   rote   ry

4. Select the three instances in which the letter combination gh is "silent":

   [following the vowel sound a]   [after the long i sound]

   [before the vowel o]   [before the letter t]

   [behind the vowel sound o]   [before the vowel sound u]

5. Two consonants are silent when they come before the letter n in a word or syllable: Type these letters (g) , (k)

6. Type the letter that is "silent" in these words: folk, salmon, balm, would, chalk. (l)

7. Which letter is silent before the sounds represented by s, t, n?

(p)

8. Type the "silent letter" rule illustrated in these words: phlegm, phragm.

(g before m is "silent")

9. Touch the word in each row which is the correct phonetic spelling of the underlined word at the beginning of each row:

A. subtler subler sutler sulter

B. climb clim clib clibm

10. Touch the letter that represents the "soft" sound of g.

(j) s z p

11. Touch the letter that represents the "soft" sound of c.

k b (s) z

12. Touch the three letters which control the "soft" sounds of c and g.

a (e) (i) o u (y) w

13. In what position is the e, i, or y when c or g stands for the "soft" sound?

before c or g (after c or g)

14. Which vowel gives q a sound?

a e i o (u)

15. Which letter combination stands for the sound of qu?

ck ky (kw) ku

16. Touch the word below in which s stands for its most common sound.

[his] [yes] [sure]

[1 Point]

17. Type the letter which stands for the sound of s in his and runs: (z)

[No Point]

[Total Points = 9]

PRETEST 10

A:
AUDIO MESSAGE:

Listen to the vowel sound in the second syllable of each of the words below:

button buttan buttin butten buttun

1. Touch the term which identifies the vowel sounds in the second syllable of each word:

[schwa] [short vowel sound] [accented vowel]

[No Point]

2. Use your light pen to touch the statement which best defines the schwa sound:

[accented, one syllable sound] [softening of the vowel sound]

[two consonant sounds stressed] [hardening of consonant sound]

[1 Point]

3. In which situation does the schwa sound occur?

[unstressed syllables] [monosyllabic words]

[polysyllabic words] [accented syllables]

[1 Point]

4. The schwa sound is very much like the short sound of one of the vowels. Retype the words below and substitute the vowel letter whose short sound is like the schwa sound:

shaken	shakun
elevate	eluvate

[.5 Point]

5. The schwa sound represents all vowels in unstressed syllables.

[.5 Point]

B:

1. Which of the consonant letters below affects the sound of each vowel?

p m s (r) c

[1 Point]

2. In which position is the r in relation to the vowel when it affects the vowel sound? follows vowel

[1 Point]

3. Which term most adequately describes the resultant sound of a vowel followed by r?

[schwa sound] [long vowel sound] [blended sound]

[short vowel sound]

[1 Point]

C:

1. The letters l, w, u and the combination ll affect the sound of which of the vowel letters below?

(a) e i o u

[1 Point]

2. Which spelling represents the resultant sound of a in all, al, or au?

ae ow (aw)

D:

1. Group these words according to the sound represented by the double oo:

boo book good blood floor cool

Long oo: boo, cool

Short oo: book, good

Neither: blood, floor

[6/6 = 1 Point]

E:

1. In the line below, three of the words follow a particular rule; one word does not. Type this word that is an exception in the space at the end of the line: (told)

   bat   melt   shop   told   drum

   [No Points]

2. You correctly identified told as the exception. Type the generalization which accounts for told as an exception:

   (o followed by ld stands for long o sound)

   [1 Point]

3. In the line below, the vowel sounds in three of the words are exceptions to a generalization for vowel sounds. Touch the word in which the vowel sound conforms to the generalization:

   wild   scoff   night   kind

   [No Points]

4. Now type a generalization to cover the vowel sounds in the words wild, night and kind:

   (i followed by ld, gh, nd stands for long i.)

[Total Points = 11]

PRETEST 11

1. Name at least three principles that the teacher should observe when introducing letter sound relationships:

    a. exaggerate but do not distort sound

    b. call letters by name

    c. never sound letter in isolation

    d. use whole words as meaningful stimulus

[2 Points Each]

2. Outline in sequence, the procedural steps in introducing a letter-sound relationship:

    1. Teacher prints letter in upper and lower case

    2. Teacher prints known stimulus words

    3. Teacher calls visual attention to similarities

    4. Teacher says each word and directs attention to sameness in sounds

    5. Children say words

    6. Children supply other words similar to stimulus word

[2 Points Each]

3. Outline the content of a phonics program in a logical sequence for presentation to children:

    Two points are awarded for beginning with single, initial consonant letters and three points for inclusiveness and logical order.

[5 Points]

[Total Points = 23]

[Total Points for Test = 92]

PHONI POSTTEST

DIRECTIONS: Answer each question as well as you can. You may make your answers brief and to the point or you may elaborate; just be sure that you include the main points.

1. Name the four prerequisites for phonic analysis and discuss each as it relates to phonic analysis instruction.

sight vocabulary: serves as phonic models

auditory discrimination: hear differences in sounds in words

visual discrimination: see differences in printed letters in words

letters by name and shape: communication purposes

[6 Points]

2. Outline the content of a phonics program in a logical sequence for presentation. Use major headings.

A. Single initial consonant letters [2 Points]

B. Consonant blends

C. Consonant digraphs

D. Short vowel sounds [3 Points]

E. Long vowel sounds

F. Vowel combinations

G. Consonant irregularities

H. Vowel irregularities

The program stressed beginning with single consonant letters; two points are awarded for this beginning. One-half of a point is awarded for each heading included and one-half a point is given for logical order throughout.

[5 Points]

3. Describe a consonant blend and name the two-letter consonant blends:

Combination of two or three consonant letters that result in a sound that is a blend of the sounds represented by the single consonant letters.

OR

Two consonant letters that produce a sound in which the sound represented by each letter is distinguishable.

f: br, cr, dr, fr, gr, pr, tr

l: bl, cl, fl, gl, pl, sl s: sc, sk, sw, sp, sm, sn, st

[17/20 = 3 Points]

4. Define a consonant digraph and list the consonant digraphs that are to be included in a phonics program: then name the letter or letter combinations representing the digraph sounds which are not the same as the letters of which the digraph is made.

a) Definition:

Combination of two consonant letters that produces a single, distinct sound (which may be represented by a letter or letter combinations different from the letters of the digraph).

b) Digraphs:

ch, gh, ph, sh, th, wh, ck, ng

c) ch = k gh = f ph = f

[4 Points]

5. Write a word in which the vowel letter represents the short vowel sound of:

Examples

a	at	cat
e	el	hep
i	it	nip
o	on	cot
u	up	cup

[2 Points]

6. State the generalization(s) for short vowel sounds in words: only vowel in closed syllable stands for short vowel sound; only vowel at beginning of word stands for short vowel sound; only vowel in middle of word stands for short vowel sound.

[3 Points]

7. Syllabicate the following words; next to each word, write the rule governing its syllabic division:

   a) drummer - drum/mer: divide between two consonants

   b) beckon -

   c) donut - do/nut: single consonant between two vowels goes with second vowel

   d) ladle -

[4 Points]

8. Name the instances in which y and w represent vowel sounds. Then describe the resultant vowel sound:

instances	vowel sound
a) y - no other vowel in word	y in closed syllable: short i
	y and no other vowel at end of syllable; long i
b) w - immediately follows same syllable	y at end of two-syllable word: long e or short i

[5 Points]

9. Write one word for each of the vowel letters below in which the long sound of that vowel letter is represented.

   a rā

   e mē

   i hīke

   o gō

   u fūme

[2 Points]

10. Write the "final" e generalization and give one example.

When there are two vowels in a word, one of which is final e and the vowels are separated by a consonant, the first vowel (usually stands for the) long sound and the final e is "silent."

[5 Points]

11. Give the "single-final" generalization and give one example.

A single vowel at the end of a word or syllable usually stands for the long vowel sound.

[3 Points]

12. Write the "modified" adjacent vowel generalization: and the vowel letter combinations which adhere to it most consistently.

When these vowel combinations are in the same syllable the first vowel usually stands for the long sound and the second vowel is "silent.": ee, ea, oe, ai, ay, oa

[4 Points]

13. Describe a vowel digraph.

Adjacent vowel combination that results in a single, distinct vowel sound.

[2 Points]

14. Describe the qualities of a diphthong.

Adjacent vowel combination that records a single, blended sound.

[2 Points]

15. List the "common" diphthongs and write a key word for each diphthong sound. (Note: one key word may serve two diphthongs.)

oi
key - boy
oy

ow
key - out
ou

[2 Points]

16. Type the rule governing the sounds represented by c and g in these words:

civil

gentle

Rule: When c and g are followed by e, i, or y they represent their "soft" sounds.

[3 Points]

17. Next to each of the consonant letters or letter combinations, give the instance(s) in which the letter or letter combination does not represent a sound in words:

b after m, before t in same syllable	[comb, debt]
h before vowel sound, after r, at end of word	[ah, rhett]
k before n in same syllable	[knight]
l before m, before k in same syllable	[balm, folk]
p before n, s or t in same syllable	[pheumonia, pseudo ptomaine]
g before n or m in same syllable	[gnat, plegm]
gh following long i, long a vowel sound before t	[night, weight caught]
w before r in same syllable	[write]

Note: Examples such as those given to the right were acceptable.

[4 Points]

18. Name the letter combination whose sound is represented by kw.

qu

[1 Point]

19. Give a word in which s represents its most common sound.

yes

[1 Point]

20. Describe the vowel sound in the words below:

bar

her

snare

sure

The vowel sounds in the words are controlled by the letter r which immediately follows the vowel. The sound is neither long, or short, but is a "blend" of the vowel sound and the sound represented by the letter r.

[3 Points]

21. Name the letter combinations which stand for the vowel sound heard in "brought."

al, all, au, aw

[2 Points]

22. Describe the "schwa" sound and tell in which instances is occurs in words:

The schwa sound is similar to a softened, short u sound.

The schwa sound usually occurs in unaccented syllables.

[3 Points]

23. Name the oo sound represented in each of the words below:

hook short   toot long

blood neither

[1 Point]

24. Give the generalization for the vowel sound in the words below:

a) Gold - o followed by ld usually represents the long o sound.

b) Light, mild, rind - i followed by gh, ld, nd, usually stands for the long i sound.

[1 Point Per Answer]

25. Name at least three principles to be observed in introducing letter-sound relationships:

    a) complete word or meaningful stimulus

    b) call letter by name

    c) emphasize but do not distort sound

    d) sound no letter in isolation

    e) associate with both capital and lower case

[2 Points Per Answer]

26. Give the steps in a general procedural outline that could be used to introduce letter-sound relationships:

    1. Print letter in capital and lower case

    2. Print several familiar (sight) words on board

    3. Ask children to see how words are alike

    4. Pronounce words; ask children to listen to sound represented by the letter being emphasized.

    5. Have children say words and listen to sound represented by letter as they pronounce words

    6. Ask children for other words with same sound (vowel or consonant) as emphasized in stimulus words

[2 Points Per Answer]

[Total Points = 92]

APPENDIX H

FORM C: INCOURSE ITEMS ANALYSIS FORMS

Form C: Incourse Items Analysis

Segment	EP Identifier	Number Presented EP	Number of Correct First Responses	Number of Incorrect Last Responses	Difficulty Level	Mean Number of Responses to EP	Number of Students Having Response Latencies > 1 Min.	Response Mode
Phoni I	aa03a 1	36	29	3	81	1	6	Keyboard: Constructed fill-in
	aa10a 1	23	23	0	100	1	1	"
	aa12a 1	25	23	1	96	1	3	"
	aa14a 1	23	12*	3	87	2	0	"
	aa17a 1	34	5*	5	85	3	12	"
	aa36a 7R	36	36	0	100	1	0	Light Pen
	aa37a 7R	36	31	5	86	1	0	" "
	aa38a 7R	36	26*	10	72*	1	0	" "
	aa39a 7R	36	26*	10	72*	1	0	" "
	aa40a 7R	36	33	3	92	1	0	" "

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*See Chapter IV, pages 109 - 115 for discussion of starred items.

Form C: Incourse Items Analysis (Continued)

Segment	EP Identifier	Number Presented EP	Number of Correct First Responses	Number of Incorrect Last Responses	Difficulty Level	Mean Number of Responses to EP	Number of Students Having Response Latencies > 1 Min.	Response Mode
Phoni I (Cont.)	aa41a 7R	36	36	0	100	1	0	Light Pen
	aa44a 7	36	31	5	86	1	0	" "
	aa46a 7	36	15	21	42*	1	3	" "
	aa58a 7	36	35	0	100	1	0	" "
	aa59a 7	36	36	0	100	1	0	" "
	aa61a 7	36	31	5	86	1	0	" "
	aa74a b3	36	16*	7	81	2	8	Keyboard Multi-lined
	aa74d b3	36	6	16	56*	3	12	"
	aa75a b3	36	6	28	22*	2	2	"
	aa76a b3	36	4	24	33*	2	3	"
	aa77a b3	36	27*	4	89	1	2	"
	aa78a b3	34	21	9	74*	1	0	"

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*See Chapter IV, pages 109 - 115 for discussion of starred items.

Form C: Incourse Items Analysis (Continued)

Segment	EP Identifier	Number Presented EP	Number of Correct First Responses	Number of Incorrect Last Responses	Difficulty Level	Mean Number of Responses to EP	Number of Students Having Response Latencies > 1 Min.	Response Mode
Phoni II	ca05a 7	15	13	1	93	1	1	Light Pen
	ca14a a1	33	28	0	100	1	2	Keyboard: Fill-in
	ca14a b1	33	31	0	100	1	0	"
	ca14a c1	33	31	0	100	1	2	"
	ca14a d1	33	30	0	100	1	2	"
	ca14n 1	33	23*	0	100	1	4	"
	ca16a 1	33	24*	0	100	1	0	"
	ca18a 7	33	20*	0	100	1	0	Light Pen
	ca21a 1R	35	24*	0	100	1	0	Keyboard: Fill-in
	ca21c 1R	35	34	0	100	1	1	"
	ca23a 7R	11	9	0	100	1	0	Light Pen

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*See Chapter IV, pages 109 - 115 for discussion of starred items.

Form C: Incourse Items Analysis (Continued)

Segment	EP Identifier	Number Presented EP	Number of Correct First Responses	Number of Incorrect Last Responses	Difficulty Level	Mean Number of Responses to EP	Number of Students Having Response Latencies > 1 Min.	Response Mode
Phoni II (Cont.)	ca24a 7R	3	3	0	100	1	1	Light Pen
	ca25a 7R	10	2*	0	100	2	2	" "
	ca37a a3	35	21	14	54*	1	5	Keyboard: Multi-lined
	ca37a b7	35	30	5	86	1	1	Light Pen
	ca38a a3	35	11	24	29*	1	2	Keyboard: Multi-lined
	ca38a b7	35	23	12	66*	1	2	Light Pen
	ca39a a3	35	23	11	69*	1	1	Keyboard: Multi-lined
	ca39a b7	35	24	10	69*	1	1	Light Pen
	ca40a a3	35	29	6	72*	1	1	Keyboard: Multi-lined

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*See Chapter IV, pages 109 - 115 for discussion of starred items.

Form C: Incourse Items Analysis (Continued)

Segment	EP Identifier	Number Presented EP	Number of Correct First Responses	Number of Incorrect Last Responses	Difficulty Level	Mean Number of Responses to EP	Number of Students Having Response Latencies > 1 Min.	Response Mode
Phoni II (Cont.)	ca40a b7	35	32	3	91	1	0	Light Pen
	ca41a a3	35	31	4	89	1	0	Keyboard: Multi-lined
	ca41a b7	35	34	1	97	1	0	Light Pen
	ca42a a3	35	23	12	40*	1	8	Keyboard: Multi-lined
	ca42a b7	35	19	16	54*	1	0	Light Pen
Phoni III	cf19a a3	33	28	5	82	1	6	Keyboard: Multi-lined
	cf19a b7	33	32	1	97	1	18	Light Pen
	cf10a 1	36	32	0	100	1	7	Keyboard: Fill-in

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*See Chapter IV, pages 109 - 115 for discussion of starred items.

Form C: Incourse Items Analysis (Continued)

Segment	EP Identifier	Number Presented EP	Number of Correct First Responses	Number of Incorrect Last Responses	Difficulty Level	Mean Number of Responses to EP	Number of Students Having Response Latencies > 1 Min.	Response Mode
Phoni III (Cont.)	cf23a a1	36	32	4	89	1	1	Keyboard: Fill-in
	cf23a b1	36	33	3	92	1	0	"
	cf23a c1	36	28	8	78*	1	1	"
	cf23a d1	36	29	7	81	1	1	"
	cf63a a3	36	30	6	83	1	1	Keyboard: Multi-lined
	cf63a b7	36	30	6	83	1	0	Light Pen
	cf64a a3	36	25	11	64*	1	0	Keyboard: Multi-lined
	cf64a b7	36	27	9	75*	1	0	Light Pen
	cf65a a3	36	33	3	89	1	0	Keyboard: Multi-lined

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*See Chapter IV, pages 109 - 115 for discussion of starred items.

Form C: Incourse Items Analysis (Continued)

Segment	EP Identifier	Number Presented EP	Number of Correct First Responses	Number of Incorrect Last Responses	Difficulty Level	Mean Number of Responses to EP	Number of Students Having Response Latencies > 1 Min.	Response Mode
Phoni III (Cont.)	cf65a b7	36	32	4	89	1	1	Light Pen
	cf66a a3	36	33	3	94	1	2	Keyboard: Multi-lined
	cf66a b7	36	34	2	94	1	0	Light Pen
	cf67a a3	36	33	33	92	1	0	Keyboard: Multi-lined
	cf67a b7	36	33	3	92	1	0	Light Pen
	cf68a a3	36	16	20	44*	1	1	Keyboard: Multi-lined
	cf68a b7	36	18	18	50*	1	0	Light Pen
	cf33a a1R	36	32	4	89	1	0	Keyboard: Fill-in

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*See Chapter IV, pages 109 - 115 for discussion of starred items.

Form C: Incourse Items Analysis (Continued)

Segment	EP Identifier	Number Presented EP	Number of Correct First Responses	Number of Incorrect Last Responses	Difficulty Level	Mean Number of Responses to EP	Number of Students Having Response Latencies > 1 Min.	Response Mode
Phoni III (Cont.)	cf33a b1R	36	28	8	78*	1	1	Keyboard Fill-in
	cf33b a1R	36	36	0	100	1	0	"
	cf33b b1R	36	10	26	28*	1	0	"
	cf33b c1R	36	30	6	83	1	0	"
	cf33b d7R	36	33	3	92	1	0	"
	cf33c a1R	36	33	3	92	1	0	"
	cf33c b1R	36	36	0	100	1	0	"
	cf33c c7R	36	28	8	78*	1	0	"
	cf33d a1R	36	36	0	100	1	3	"

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*See Chapter IV, pages 109 - 115 for discussion of starred items.

Form C: Incourse Items Analysis (Continued)

Segment	EP Identifier	Number Presented EP	Number of Correct First Responses	Number of Incorrect Last Responses	Difficulty Level	Mean Number of Responses to EP	Number of Students Having Response Latencies > 1 Min.	Response Mode
Phoni IV	va09a a3	36	26	10	72*	1	0	Keyboard: Multi-lined
	va09a 7	36	32	4	89	1	2	Light Pen
	va10a 7	36	24	12	67*	1	0	" "
	va11a a1R	36	36	0	100	1	1	Keyboard: Fill-in
	va11a b1R	36	35	0	100	1	0	"
	va11a c1R	36	35	0	100	1	0	"
	va11a d1R	36	35	1	97	1	0	"
	va19a a3	36	30	6	83	1	2	Keyboard: Multi-lined
	va19a b7	36	34	0	100	1	22	Light Pen
	va27a a3	36	35	1	97	1	1	Keyboard: Multi-lined

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*See Chapter IV, pages 109 - 115 for discussion of starred items.

Form C: Incourse Items Analysis (Continued)

Segment	EP Identifier	Number Presented EP	Number of Correct First Responses	Number of Incorrect Last Responses	Difficulty Level	Mean Number of Responses to EP	Number of Students Having Response Latencies > 1 Min.	Response Mode
Phoni IV (Cont.)	v[illegible]27a b7	36	35	1	97	1	8	Light Pen
	vc01a 7	29	24	0	100	1	2	" "
	vc02a 7	29	26	0	100	1	0	" "
	vc03a 7	29	28	0	100	1	2	" "
	vc04a 7	29	29	0	100	1	0	" "
	vc05a 7	29	29	0	100	1	0	" "
	vc07a b1	29	26	3	90	1	1	Keyboard: Fill-in
	vc08a a3	10	5	5	50*	1	0	Keyboard: Multi-lined
	vf02a 7R	36	29	7	81	1	0	Light Pen
	vf02a 5R	29	27	2	93	1	1	Keyboard: Multiple Choice

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*See Chapter IV, pages 109 - 115 for discussion of starred items.

Form C: Incourse Items Analysis (Continued)

Segment	EP Identifier	Number Presented EP	Number of Correct First Responses	Number of Incorrect Last Responses	Difficulty Level	Mean Number of Responses to EP	Number of Students Having Response Latencies > 1 Min.	Response Mode
Phoni IV (Cont.)	vf03a 7R	36	31	5	86	1	1	Light Pen
	vf03a 5R	31	28*	3	90	1	0	Keyboard: Multiple Choice
	vf04a 7R	36	29	7	81	1	1	Light Pen
	vf04a 5R	29	26	3	90	1	1	Keyboard: Multiple Choice
	vf05a 7R	36	29	7	81	1	0	Light Pen
	vf05a 5R	29	25	4	86	1	0	Keyboard: Multiple Choice
	vf06a 7R	36	21	15	58*	1	0	Light Pen

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*See Chapter IV, pages 109 - 115 for discussion of starred items.

Form C: Incourse Items Analysis (Continued)

Segment	EP Identifier	Number Presented EP	Number of Correct First Responses	Number of Incorrect Last Responses	Difficulty Level	Mean Number of Responses to EP	Number of Students Having Response Latencies > 1 Min.	Response Mode
Phoni IV (Cont.)	vf06a 5R	21	20	1	95	1	0	Keyboard: Multiple Choice
	vf07a 7R	36	28	8	78*	1	0	Light Pen
	vf07a 5R	28	24	4	86	1	0	Keyboard: Multiple Choice
	vf08a 7R	36	23	13	64*	1	1	Light Pen
	vf08a 5R	23	21	2	91	1	1	Keyboard: Multiple Choice
	vf09a 7R	36	22	14	61*	1	0	Light Pen
	vf09a 5R	22	13	9	59*	1	0	Keyboard: Multiple Choice

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*See Chapter IV, pages 109 - 115 for discussion of starred items.

Form C: Incourse Items Analysis (Continued)

Segment	EP Identifier	Number Presented EP	Number of Correct First Responses	Number of Incorrect Last Responses	Difficulty Level	Mean Number of Responses to EP	Number of Students Having Response Latencies > 1 Min.	Response Mode
Phoni IV (Cont.)	vfl0a 7R	36	26	10	72*	1	0	Light Pen
	vfl0a 5R	27	26	1	96	1	0	Keyboard: Multiple Choice
	vfl1a 7R	36	20	16	56*	1	0	Light Pen
	vfl1a 5R	20	18	2	90	1	0	Keyboard: Multiple Choice
	vgl0a a1	31	31	0	100	1	1	Keyboard: Fill-in
	vgl0a b1	31	30	0	100	1	0	"
	vgl0a c1	31	13	11	65*	2	0	"
	vgl2a 3	31	16	15	52*	1	1	Keyboard: Multi-lined

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*See Chapter IV, pages 109 - 115 for discussion of starred items.

Form C: Incourse Items Analysis (Continued)

Segment	EP Identifier	Number Presented EP	Number of Correct First Responses	Number of Incorrect Last Responses	Difficulty Level	Mean Number of Responses to EP	Number of Students Having Response Latencies > 1 Min,	Response Mode
Phoni IV (Cont.)	vg17a 3	31	20	11	65*	1	11	Keyboard: Multi-lined
	vg20a a1	31	27	2	94	1	1	Keyboard: Fill-in
	vg20a b1	31	20	7	77*	1	1	"
	vg20a c1	31	20*	6	81	1	0	"
	vg20a d1	22	15*	4	82	1	2	"
	vg23a 3	18	17	1	94	1	3	Keyboard: Multi-lined
	vg25a a1	36	30	6	83	1	0	Keyboard: Fill-in
	vg25a b7	6	4	2	67*	1	0	Light Pen
	vg25a c7	2	1	1	50*	1	0	" "

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*See Chapter IV, pages 109 - 115 for discussion of starred items.

Form C: Incourse Items Analysis (Continued)

Segment	EP Identifier	Number Presented EP	Number of Correct First Responses	Number of Incorrect Last Responses	Difficulty Level	Mean Number of Responses to EP	Number of Students Having Response Latencies > 1 Min.	Response Mode
Phoni IV (Cont.)	vg26a a1	36	24	12	67*	1	1	Keyboard: Fill-in
	vg26a b7	12	7	5	58*	1	0	Light Pen
	vg26a c7	5	3	2	60*	1	0	" "
	vg27a a1	36	25*	3	92	2	8	Keyboard: Fill-in
	vg27a b7	3	0	3	0*	1	0	Light Pen
	vg27a c7	3	3	0	100	1	0	" "
	vg28a a1	36	27*	0	100	2	5	Keyboard: Fill-in
	vg28a b3	36	25	11	69*	2	0	Keyboard: Multi-lined
	ve07a K	16	10	2	88	1	2	Keyboard: Multi-lined

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*See Chapter IV, pages 109 - 115 for discussion of starred items.

Form C: Incourse Items Analysis (Continued)

Segment	EP Identifier	Number Presented EP	Number of Correct First Responses	Number of Incorrect Last Responses	Difficulty Level	Mean Number of Responses to EP	Number of Students Having Response Latencies > 1 Min.	Response Mode
Phoni IV (Cont.)	ve09a aK	36	15	21	42*	1	1	Keyboard: Multi-lined
	ve09a b7	36	21	15	58*	1	26	Light Pen
	ve11a aK	36	18	18	50*	1	2	Keyboard: Multi-lined
	ve11a b7	18	16	2	89	1	0	Light Pen
	ve13a K	36	6	11	69*	2	6	Keyboard: Multi-lined
	ve17a c1R	36	35	1	97	1	0	Keyboard: Fill-in
	ve17a a1R	36	31	5	86	1	1	"
	ve17a b1R	36	31	5	86	1	7	"
	ve17b a1R	36	32	4	89	1	0	"

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*See Chapter IV, pages 109 - 115 for discussion of starred items.

Form C: Incourse Items Analysis (Continued)

Segment	EP Identifier	Number Presented EP	Number of Correct First Responses	Number of Incorrect Last Responses	Difficulty Level	Mean Number of Responses to EP	Number of Students Having Response Latencies > 1 Min.	Response Mode
Phoni IV (Cont.)	ve17b b1R	36	22	14	61*	1	2	Keyboard: Fill-in
	ve17b c1R	36	27	9	75*	1	2	"
	ve17c a1R	36	33	3	92	1	0	"
	ve17c b1R	36	34	2	94	1	0	"
Phoni V	wa07a a1	36	36	0	100	1	2	"
	wa07a b1	36	26	10	72*	1	0	"
	wa07a c1	36	24*	0	100	1	2	"
	we05a 5	36	28	0	100	1	2	Keyboard: Multiple Choice
	we06a 5	36	17*	0	100	2	2	"

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*See Chapter IV, pages 109 - 115 for discussion of starred items.

Form C: Incourse Items Analysis (Continued)

Segment	EP Identifier	Number Presented EP	Number of Correct First Responses	Number of Incorrect Last Responses	Difficulty Level	Mean Number of Responses to EP	Number of Students Having Response Latencies > 1 Min.	Response Mode
Phoni V (Cont.)	we07a c7	15	12	0	100	2	0	Light Pen
	we07a d7	7	4*	0	100	4	1	" "
	we07a a7	36	26*	0	100	2	2	" "
	we07a b7	36	14	22	36*	1	0	" "
	we08a 1	36	34	0	100	1	0	Keyboard: Fill-in
	we09a a1	36	14*	0	100	4	3	"
	we09a b1	36	31	0	100	1	0	"
	we09a c1	36	35	0	100	1	0	"
	we10a 1	36	34	0	100	1	4	"
	we11a 7	36	28	0	100	1	2	Light Pen
	wg06a a1	36	14*	0	100	2	1	Keyboard: Fill-in

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*See Chapter IV, pages 109 - 115 for discussion of starred items.

Form C: Incourse Items Analysis (Continued)

Segment	EP Identifier	Number Presented EP	Number of Correct First Responses	Number of Incorrect Last Responses	Difficulty Level	Mean Number of Responses to EP	Number of Students Having Response Latencies > 1 Min.	Response Mode
Phoni V (Cont.)	wg06a b1	36	33	3	92	1	0	Keyboard: Fill-in
	wg10a 1	36	26*	0	100	1	7	"
	wm02a 1R	36	5	31	14*	1	13	"
	wm02a b7R	36	13	23	36*	1	11	Light Pen
	wm05a 7R	36	34	0	100	1	2	" "
	wm06a 7R	36	32	0	100	1	0	" "
	wm07a 7R	36	32	0	100	1	2	" "
	wm08a a1R	36	35	1	97	1	1	Keyboard: Fill-in
	wm08a b1R	36	24	12	67*	1	0	"
	wm08a c1R	36	35	1	97	1	0	"

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*See Chapter IV, pages 109 - 115 for discussion of starred items.

Form C: Incourse Items Analysis (Continued)

Segment	EP Identifier	Number Presented EP	Number of Correct First Responses	Number of Incorrect Last Responses	Difficulty Level	Mean Number of Responses to EP	Number of Students Having Response Latencies > 1 Min.	Response Mode
Phoni V (Cont.)	wm08a d1R	36	33	3	92	1	0	Keyboard: Fill-in
	wm08a e1R	36	34	2	94	1	0	"
Phoni VI	ec08a a1	30	28	0	100	1	0	"
	ec11a a1	30	28	0	100	1	1	"
	ec11a b1	30	21*	0	100	1	0	"
	ec18a 1	11	6*	0	100	2	8	"
	ec19a a1	13	12	0	100	1	1	"
	ec19a b1	13	5*	0	100	2	0	"
	ec23a 1	8	7	1	88	1	0	"
	ec24a a1	15	11	0	100	1	2	"

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*See Chapter IV, pages 109 - 115 for discussion of starred items.

Form C: Incourse Items Analysis (Continued)

Segment	EP Identifier	Number Presented EP	Number of Correct First Responses	Number of Incorrect Last Responses	Difficulty Level	Mean Number of Responses to EP	Number of Students Having Response Latencies > 1 Min.	Response Mode
Phoni VI (Cont.)	ec24a b1	15	9*	0	100	1	1	Keyboard: Fill-in
	ec24a c1	15	10	0	100	1	2	"
	ec24a d1	15	7*	0	100	1	1	"
	ec26a a1	2	1	0	100	1	0	"
	ec26a b1	2	1	0	100	1	0	"
	ec27a a1	31	31	0	100	1	0	"
	ec27a b1	31	30	0	100	1	0	"
	ec28a a1	27	25	0	100	1	0	"
	ec28a b1	27	19*	0	100	1	1	"
	ec28a c7	22	21	0	100	1	0	Light Pen
	ec30a a1	19	17	0	100	1	0	Keyboard: Fill-in

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*See Chapter IV, pages 109 - 115 for discussion of starred items.

Form C: Incourse Items Analysis (Continued)

Segment	EP Identifier	Number Presented EP	Number of Correct First Responses	Number of Incorrect Last Responses	Difficulty Level	Mean Number of Responses to EP	Number of Students Having Response Latencies > 1 Min.	Response Mode
Phoni VI (Cont.)	ec30a b7	19	3*	2	89	2	2	Light Pen
	ec31a a1	26	22	0	100	1	0	Keyboard: Fill-in
	ec31a b1	26	24	0	100	1	0	"
Phoni VII	vj06a a1	35	23*	3	91	2	3	"
	vj06a b1	35	28	2	94	1	1	"
	vj06a c1	35	34	1	97	1	1	"
	vj06a d1	35	32	2	94	1	0	"
	vj06a e1	35	28	2	94	1	0	"
	vj08a 3	36	21	15	58*	1	3	Keyboard: Multi-lined

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*See Chapter IV, pages 109 - 115 for discussion of starred items.

Form C: Incourse Items Analysis (Continued)

Segment	EP Identifier	Number Presented EP	Number of Correct First Responses	Number of Incorrect Last Responses	Difficulty Level	Mean Number of Responses to EP	Number of Students Having Response Latencies > 1 Min.	Response Mode
Phoni VII (Cont.)	vp04a 1	35	25	10	71*	1	1	Keyboard: Fill-in
	vm06a a1	31	22*	5	84	1	0	"
	vm06a b1	31	18	13	58*	1	2	"
	vs04a a5	36	32	0	100	1	0	Keyboard: Multiple Choice
	vs04a b5	36	26*	0	100	1	0	"
	vs04a c5	36	34	0	100	1	0	"
	vs04a d5	36	31	0	100	1	0	"
	vs04a e5	36	28	0	100	1	0	"
	vs04a f5	36	34	0	100	1	0	"

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*See Chapter IV, pages 109 - 115 for discussion of starred items.

Form C: Incourse Items Analysis (Continued)

Segment	EP Identifier	Number Presented EP	Number of Correct First Responses	Number of Incorrect Last Responses	Difficulty Level	Mean Number of Responses to EP	Number of Students Having Response Latencies > 1 Min.	Response Mode
Phoni VII (Cont.)	vs04a g5	36	28	0	100	1	0	Keyboard: Multiple Choice
	vs04a h5	36	32	0	100	1	0	"
	vs05a a1	36	27*	3	92	1	0	Keyboard: Fill-in
	vs05a b1	36	29	7	81	1	0	"
	vs05a c5	36	28	8	78*	1	0	Keyboard: Multiple Choice
	vs05a d5	36	32	4	89	1	0	"
	vv02a a1	36	35	0	100	1	0	Keyboard Fill-in

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*See Chapter IV, pages 109 - 115 for discussion of starred items.

Form C: Incourse Items Analysis (Continued)

Segment	EP Identifier	Number Presented EP	Number of Correct First Responses	Number of Incorrect Last Responses	Difficulty Level	Mean Number of Responses to EP	Number of Students Having Response Latencies > 1 Min.	Response Mode
Phoni VII (Cont.)	vv02a b3	36	30	6	83	1	1	Keyboard: Multi-lined
	vv02a c1	6	6	0	100	1	0	Keyboard: Fill-in
	vv07a 3	36	27*	3	92	1	0	Keyboard: Multi-lined

*See Chapter IV, pages 109 - 115 for discussion of starred items.

APPENDIX I

COMMENTS FROM THE VALIDATION GROUP

COMMENTS ON THE COURSE

A. Very interesting.

The generalizations were hardest for me. I wished there weren't so much "writing of the generalizations" - but that's probably what I need. But as you see from the posttest, I do not tend to remember wordings, but think I am nearly able to formulate in my own words. The danger is that my formulations might not be as accurate and clear as the program's.

I think the demonstrative lessons would be great for pre-service teachers. Like a Montessori method, it gives them at least one way that works - and to start out they need that!

B. PCO0

1. Very well organized!

2. Not too sure about computer teaching - too many foul ups for me. But otherwise good technique for individualized instruction.

3. I feel I gained a good understanding of phonics considering I never had it before.

4. Would have done better had more time been allowed. One hour long enough at a time.

5. Feel this should be made into a required course, especially to prospective teachers!!!

C. PRR

I have no comment about this course in the fact that it did teach phonics and I know the notes that I received from the course will help me greatly even if I can't say the rules from mind. They will be a good reference for me. Thanks.

D. PCK

Since this is the first and only teaching phonics course I've had, I guess my evaluation might not be really objective.

I thought the course was worthwhile. It presented a practical approach to dealing with phonics in the elementary schools. It seemed to cover all the areas that most teachers would be concerned about,--i.e., those areas that would be difficult to introduce. The lesson was applicable to all areas therefore easy for teachers to remember.

I think the course will help me as a teacher and I'm glad I took it because otherwise I probably would never had had such an in-depth instruction to teaching phonics. And I liked working with the computers. It was a good experience to experience the advantages and disadvantages of computerized programming.

E. PDK

I think the course was well worth while. There was adequate repetition which enabled many concepts to be recalled, and I also have my notes for future reference. I think it is a very effective way to present phonics. If I had to learn the process in class, I probably would have been bored to death. By using the computer, I not only was introduced to computerized instruction, but also was kept actively involved in the learning process. I was especially glad to have taken the course when I found that a girl who was student teaching where I will be next term gave 50 phonics lessons in the first five weeks. I knew nothing about it before, but now I have a good foundation to build on.

F. PCO

Very helpful. I knew nothing at all before the course. I think that these types of courses should be available in other areas, too.

G. PJG

At times I didn't know something or I wanted to question something and I was unable. For example, it was very frustrating when I didn't know something and the computer kept saying, "try again, etc." and then I didn't find out anyway. I enjoyed the program and benefited by it.

H. PCV

I feel this course was very good because it presented material which I really didn't know or understand as it really wasn't covered in my elementary years. I feel it will be very beneficial to me when I start teaching.

I. PSN

I liked it--but I'm not going to have to sit through a whole course in it--and that's nice. The program would have to be a lot smoother (not just the mechanical failures--there were many pauses and gaps in transitions and responses to input) to have a full course. I ran into trouble with the different phonetic context used in the vowel section but feel that this isn't necessarily important for phonics instruction on the elementary school level. As educators though, I feel that teachers of reading should at least have an awareness of these phonetic differences before they go into a teaching situation.

There were times when the program itself frustrated me--not accepting correct answers, slow responses and transitions. But I am really glad that I have participated in your project--have learned more than phonics instruction. Thank you.

P. S. Your final test is much too long.

J. PDB

I enjoyed it, great learning experience, like one-to-one learning teaching situation. Think computers are programmed well. Think more courses should be given this way . . . .

K. PNM

I felt the course was structured well because I feel it dealt with a great many aspects of phonics and phonics instruction. It really did present a great deal of repetition and things were always being reviewed which I feel is good. The only thing I felt was wrong was this posttest. I feel it was really too much.

L. PDF

The course was good in that I gained a lot of knowledge about phonics instruction. Also, I like the fact that it was taught by computer--I find the computer to be much more interesting than many of my profs. However, I thought the posttest was much too long.

M. PPM

Responding to questions was often frustrating when computer wouldn't accept answer because it wasn't exact words; the frames were good in that we could evaluate our own answer.

I don't think it is good to eliminate any parts of the program based on the pretest - you can answer things on the pretest according to experience with them even though you may not completely understand why.

I think the unit is a good one for those who knew nothing of phonics before. There was an awful lot of material given. I also think it was good to give the sample lesson as a way to apply our learning.

N. PPY

I thought the course was good; interesting, to the point, easy to understand.

The text required too many memorizations of letter combinations I thought perhaps were unnecessary. They could be kept in book or notebook. But I can see why it was necessary to ask them on this particular test.

O. PMB

The course was motivating for several reasons; it was a unique and interesting process; I could compete with myself and I could go at my own pace.

Criticisms would be the troubles from the machines.

P. PMH

I thought the course was good but I like to see a teacher because then you can see his facial expressions which give clues to what he wants you to learn. I really learned a lot even though this test may not show it. But compared to what I knew when I came in, I learned a lot. I wish the machine would have gone faster and not so many illustrative lessons.

Q. PPH

Really feel [I] learned something from course.

Object to length of test--much involves only memorization of lists--I don't feel this is necessary as you can always look them up - useless memorization.

One objection to course is constant repetition of very similar lessons over again. Other than that the only objection I had was technical--too long to change frames. ENJOYED COURSE

R. PNN

I found this phonics program to be extremely helpful and worthwhile. I did enjoy working through the program and I do think it should somehow be worked into the El. Ed. curriculum because everything given in the course would be of very good use for any El. Ed. major since we are the ones who will be introducing phonics to the children.

S. PCS

I felt that the course was interesting but that the exam was not fair. It asked for total feedback of memorized material and not knowledge of material learned. I feel more emphasis should have been placed on the latter.

Working on the computer was interesting and the set-up was good. All the material I have learned will come in handy. It has already helped me in reading projects with small children. The materials could be used for later reference and that is one reason I don't understand the complex details used in the exam. Some of the questions weren't worded well enough for me to understand what you want: it may have been my interpretation of the question or incomplete headings in my notes.

T. PBH0

The course was somewhat dull after a while. It was bothersome to wait for the delay that the computer was always making. More variety in the method of presentation of material would have brought more interest. But the course did teach the principles of phonics. I am afraid that most learners though would soon forget all but the most basic principles if there is no review or follow-up. Possibly the course could be used in conjunction with other modes of instruction such as discussions, work sheets, lectures, practice teaching, etc.

There should be a way made of making the students study as they go along in the course. Possibly testing for evaluation could be done after each major section of the course instead of all at once.

U. PGH

I thought the course was outstanding. I feel that the lessons were well structured, and most importantly of all, they gave me the necessary procedure, principles, and content.

Content: everything was included. There was only one problem. In the pretest, I chose what I thought to be a ridiculous answer since I didn't know. There should be a choice box saying I don't know. Other than that, content was excellent.

Procedure: great combination of audio, CRT and image. The lessons were clear and easy to follow, and the repetition drilled procedure into my head.

Principles: the principles listed were good but the best things were the implied principles. I just can't measure the amount of information I got from this.

V. PDD

The course was well structured; it gave a good step by step presentation. I felt one sample lesson would have been sufficient. Differences for different concepts could have been mentioned, but there was much repetition which was sort of boring.

W. PKS

I feel the course was worthwhile. It made learning phonics--something that doesn't particularly excite many people--a lot more interesting. I was also interested in participating because I've heard of CAI and this is probably the only opportunity I will have in college to actually see and understand how it works. Mechanical difficulties often proved frustrating to myself and others. However, I realize this is not part of the program. This made it seem much longer than it actually was. I feel some of the questions on the posttest were rather ambiguous--not clear.

X. PMO

I think this was a worthwhile idea. It was well organized and I liked the idea of using a computer. The course however, didn't have enough examples of the areas stressed. I would feel a lot more comfortable teaching phonics now than I would have before. I also think it would be worthwhile having this for a ten-week course for prospective teachers.

Y. PAM

I enjoyed taking the phonics program, and I feel I at least learned some general information about what I had never known anything about before. This test was difficult for me because it dealt on specifics and details. Had I known this I would have been better prepared for it. I feel, though, that this course was effective and I have some valuable notes that will aid me when I do have to introduce phonics to my own class.

Z. PBT

I thought the course was very well organized sequentially and the fact that I could work at my own rate is very good. However, there were several instances during the course that a question was a bit ambiguous or just not clear in my mind. It was unfortunate that I could not ask the computer to clarify a statement or ask the instructor just what was meant by the statement. Overall, I think it was a good course and an excellent one to be used with the computer.

AA. PDC

The course was excellent. I would like to see some sections of every course done on the computer. The novelty is what made it interesting to learn not so much the content material. I also liked the self-pacing and optional reviews at the end of each section.

APPENDIX J

OPERATIONS ANALYSIS QUESTIONNAIRES

OPERATIONS ANALYSIS FOR PHONI

AUTHOR

Please answer each question below as thoroughly as you can. The comments and recommendations you make will be used to optimize future course operations for the Phoni program.

1. What specific operations did you perform in the development and/or operation of the Phoni program?

   a. selected course topic
   b. wrote scope and sequence of instruction
   c. authored all instructional materials
   d. edited and checked course materials on-line
   e. tested materials with testing groups
   f. revised and retested materials
   g. developed validation plan and ran validation study
   h. drew and described images on image request forms
   i. arranged for narration and special effects for audio recordings
   j. scheduled and supervised students
   k. requested and analyzed student records

2. Did you experience any complications or undue difficulties in performing these operations for the Phoni program? If so, could you specify the task and the difficulty?

   a. lack of programming time and other technical support because of lack of funds
   b. technical difficulties due to systems breakdown
   c. some difficulties because of programming "bugs"
   d. not being fully aware of computer capabilities

3. What recommendations can you make for improving these operations in future course development? What suggestions can you give so that such complications can be avoided in future operations?

   a. author sophistication with computer capabilities
   b. author knowledge of programming and especially of proctor usages to cope with "bugs" as they arise in program

c. knowing exactly what data may be obtained and in what form

d. do not make any last minute changes that cannot be properly tested

e. do not undertake any project without complete assurance of funding

f. thorough paper organizing and editing before putting material on-line

g. very close communication and planning between all technical staff and before beginning any authoring

4. Do you have any general recommendations for the future optimization of this product?

   a. revise materials and update edit functions as recommended in text

   b. retest materials under conditions suggested

   c. continue to use course

5. Did you note any practices followed in the operational stages of this program that you believe should be maintained, incorporated in other projects or that you noted as assets?

   a. experimenting with various strategies

   b. author proctoring

OPERATIONS ANALYSIS FOR PHONI

PROGRAMMER

Please answer each question below as thoroughly as you can. The comments and recommendations you make will be used to optimize future course operations for the Phoni program.

1. What specific operations did you perform in the development and/or operation of the Phoni program?
   a. developed labeling scheme for coordinating audio, image and CRT
   b. prepared authored material for input
   c. logged image requests and forwarded to graphic artist
   d. debugged initial on-line material
   e. proofread, edited and annotated audio sheets prior to narration
   f. made on-line revisions and corrections from author suggestions
   g. listened to initial audio recording, adjusted message lengths, noted where rerecording was necessary
2. Did you experience any complications or undue difficulties in performing these operations for the Phoni program? If so, could you specify the task and the difficulty?
   a. bugs in program resulted from changes in audio script at time of recording with no notification to programmer
   b. last minute revisions by author before a student run
   c.
   d.
   e.
3. What recommendations can you make for improving these operations in future course development? What suggestions can you give so that such complications can be avoided in future operations?
   a. all changes in audio, image, or program be noted in written communication (and dated) between author and programmer
   b.
   c.
   d.

4. Do you have any general recommendations for the future optimization of this product?

   Only through use and review based on student performance and comments can optimization be achieved.

5. Did you note any assets of this program that you believe should be maintained or that were outstanding features?

   a. creative use of the media
   b. individualization of course material determined by student need and student preference
   c.
   d.
   e.

OPERATIONS ANALYSIS FOR PHONI

CAI GRAPHIC ARTIST

Please answer each question below as thoroughly as you can. The comments and recommendations you make will be used to optimize future course operations for the Phoni program.

1. What specific operations did you perform in the development and/or operation of the Phoni program?

    a. prepared and tested CRT graphics
    b. prepared copies for photography
    c. assisted with photography of reel
    d.
    e.
    f.
    g.

2. Did you experience any complications or undue difficulties in performing these operations for the Phoni program? In so, could you specify the task and the difficulty?

    a. only time constraints
    b.
    c.
    d.
    e.
    f.
    g.

3. What recommendations can you make for improving these operations in future course development? What suggestions can you give so that such complications can be avoided in future operations?

    a. preplanning between author and artist
    b. final check of each image as soon as proof is developed (should be dated and filed)
    c. allow more time for image and reel production

   d. set up production schedule and follow as closely as possible

4. Do you have any general recommendations for the future optimization of this product?

   a.

5. Did you note any practices followed in the operational stages of this program that you believe should be maintained, incorporated in other projects or that you noted as assets?

   a. yes; hearty approval of the attempt to gather real information and apply it to the course preparation strategy

   b.

   c.

   d.

   e.

   f.

   g.

OPERATIONS ANALYSIS FOR PHONI

SYSTEMS ANALYST
COMPUTER OPERATOR

Please answer each question below as thoroughly as you can. The comments and recommendations you make will be used to optimize future course operations for the Phoni program.

1. What specific operations did you perform in the development and/or operation of the Phoni program?

    a. assigned student ID numbers
    b. readied system for daily time sharing
    c. systems manipulation for operational debugging
    d. process student records requests
    e.
    f.
    g.

2. Did you experience any complications or undue difficulties in performing these operations for the Phoni program? If so, could you specify the task and the difficulty?

    a. No more than usual; however, the fact that the situation cited under "c" (No. 1) exists, implies problems.
    b. It was difficult to fulfill student records requests in the short time allowed.
    c.
    d.
    e.
    f.
    g.

3. What recommendations can you make for improving these operations in future course development? What suggestions can you give so that such complications can be avoided in future operations?

    a. Allow ample time (to be determined by systems analyst after review of requests) for requests.
    b. More test runs needed to catch errors.

c. Make sure all data requested are needed

4. Do you have any general recommendations for the future optimization of this product?

   The more pressure (compression) at the beginning of a program, the less pressure in the ending.

5. Did you note any practices followed in the operational stages of this program that you believe should be maintained, incorporated in other projects or that you noted as assets?

   a. Good author-programmer coordination of efforts throughout, provided for consistency in program development.
   b.
   c.
   d.
   e.
   f.
   g.

OPERATIONS ANALYSIS FOR PHONI

TECHNICAL SUPPORT MANAGER

Please answer each question below as thoroughly as you can. The comments and recommendations you make will be used to optimize future course operations for the Phoni program.

1. What specific operations did you perform in the development and/or operation of the Phoni program?

    a. coordinate production of image reel
    b. coordinate production of audio charts
    c. coordinate system schedule
    d. administrative staff of lab
    e.
    f.
    g.

2. Did you experience any complications or undue difficulties in performing these operations for the Phoni program? If so, could you specify the task and the difficulty?

    a. had a great deal of difficulty securing the image reel on time
    b.
    c.
    d.
    e.
    f.
    g.

3. What recommendations can you make for improving these operations in future course development? What suggestions can you give so that such complications can be avoided in future operations?

    a. A very close working relationship is needed with all parties concerned.
    b. At least 6 weeks notice is needed for image reels

c. A close relationship must be established with all projects in the Lab. Care must be taken not to assume that the Lab exists for the support of only one project.

d. Adequate debugging time should be provided before the course is made available to students.

e.

f.

g.

4. Do you have any general recommendations for the future optimization of this product?

   Adequate documentation must be provided so that future employees can continue to work on Phoni without any contact with the people who developed the course. The documentation must be in order that the course could become operational in a matter of days after remaining dormant for a number of years. The CARE 1 and Elmath documentation manuals would serve as a good model.

5. Did you note any practices followed in the operational stages of this program that you believe should be maintained, incorporated in other projects or that you noted as assets?

   a. Many of the "nitty gritty" details were adequately handled by the Phoni staff.

   b. A great deal of pre-planning appears to have gone into the project prior to the time the projece became operational.

OPERATIONS ANALYSIS FOR PHONI

AUDIO SPECIALIST

Please answer each question below as thoroughly as you can. The comments and recommendations you make will be used to optimize future course operations for the Phoni program.

1. What specific operations did you perform in the development and/or operation of the Phoni program?

   a. Helped with audio recordings
   b. Assembled audio recordings into course.
   c.
   d.
   e.
   f.
   g.

2. Did you experience any complications or undue difficulties in performing these operations for the Phoni program? If so, could you specify the task and the difficulty?

   a. None
   b.
   c.
   d.
   e.
   f.
   g.

3. What recommendations can you make for improving these operations in future course development? What suggestions can you give so that such complications can be avoided in future operations?

   a.
   b.
   c.
   d.
   e.

4. Do you have any general recommendations for the future optimization of this product?

5. Did you note any practices followed in the operational stages of this program that you believe should be maintained, incorporated in other projects or that you noted as assets?

   a.
   b.
   c.
   d.
   e.
   f.
   g.